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To the South and Southeast must go credit for advancing the beef cattle industry faster than in any other sections of the United States during the past decade.

5TH EDITION

BEEF CATTLE

PREFACE

Since 1952, when the fourth edition of *Beef Cattle* was prepared, perhaps more new breeding and feeding research data related to beef cattle have been accumulated than in any equivalent previous period. In the fifth edition of the book originally written by the late R. R. Snapp in 1925 I have made revisions and additions where they were needed to bring recommendations into line with new findings Whenever possible, however, I have retained the original framework, and have made use of numerous tables that readers have reported to be of great value as teaching aids.

The discussions dealing with hormones, antibiotics, pelleting, and soilage, for example, although they were mentioned in previous editions, have been enlarged upon greatly, since such new ration additives and new methods of feeding by now have become generally adopted.

Among the new chapters is one that deals with a discussion of the heritable productive traits of beef cattle, treated from the angle of the economic possibilities available to breeders and ranchers. Dr. Earl Lasley, now of the Miner Institute, Chazy, New York, gave me valuable suggestions on this topic, and his help is appreciated. A second new chapter, which discusses the principles of feeding beef cattle, explains the concept that in order to feed ruminants adequately and economically we must recognize and understand the symbiotic relations existing between the host ruminant animal and the microflora of the paunch. The suggestions of my colleagues who reviewed this chapter, Dr. W. W. Albert and Dr. G. E. Mitchell, were also greatly appreciated. These chapters, I hope, will serve as a background for the material which they precede.

Perhaps the greatest departure from previous editions is the method of expressing the nutrient requirements for the various classes of cattle. Most instructors of "Feeds and Feeding" courses use either Morrison's Feeding Standards or the National Research Council Recommendations, or both. I felt, therefore, that this textbook would be more consistent and less confusing if the discussions of the various

beef cattle feeding programs and their respective ration recommendations incorporated both these guides. Tables giving the nutritive composition of most of the common feeds fed to beef cattle are included in the appendix in order to facilitate the balancing of rations by either of the two common methods described. Other appendix tables supply information on the carotene content of feeds in relation to their appearance and method of preservation, and on the calcium and phosphorus content of the common sources of these two mineral elements. I gratefully acknowledge the use of these tables from the National Research Council Report of the Beef Cattle Subcommittee on Animal Nutrition.

For the suggestions of instructors of beef cattle production courses in many colleges and of cattle feeders and breeders in many parts of the country I would also like to express my appreciation.

An intensive effort has been made to broaden the scope of the material in order to make the book equally helpful to students and cattlemen the country over, rather than to limit it primarily to the Corn Belt or to any other single region. Needless to say, special problems of certain areas have necessarily been omitted in order to conserve space. In general, however, I have tried to discuss principles upon which decisions relative to special problems can be based.

The material related to certain "skills" (such as fitting cattle for show or sale) has been greatly reduced. Because there is great variation in the accepted methods for such skills, I felt that the limited space in the book might be put to better use. Individual instructors can prepare laboratory exercises of this type, more appropriately.

I wish to acknowledge the generosity of the large number of professors, research and extension specialists, farm journal editors, and breed association personnel who have so kindly granted permission to use their tables, charts, photographs, and other material in this new edition. Without such assistance this revision would have been quite impossible. I have attempted to cite the source of all such materials and to give credit to the proper individuals or institutions. If I have failed to give recognition for help and materials received, it has been wholly unintentional and is deeply regretted.

A. L. Neumann

Urbana, Illinois
December, 1959

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part I

GENERAL ASPECTS OF THE BEEF CATTLE INDUSTRY

chapter 1
PROGRAMS AND AREAS OF BEEF PRODUCTION

The production of beef cattle differs from that of most other kinds of livestock in that the operation is frequently divided into several distinct steps or phases. It is possible to carry on all these phases on a single farm or ranch as successive steps of a continuous process. More often, however, one or two are carried on to the exclusion of the others, not only on individual farms, but also in agricultural regions. In addition, we have some two or three highly specialized forms of beef production that differ so much in methods of management from those commonly followed as to deserve special mention.

BEEF PRODUCTION PROGRAMS

Commercial Cow and Calf Program. The initial and most fundamental step in the beef enterprise is the production of a baby calf and raising it to weaning age. The calf is, so to speak, the raw material out of which the finished beast will eventually be made. The breeding herds in which calves are produced need little grain or other fattening feeds. Consequently, the raising of beef calves is confined chiefly to those sections that have an abundance of comparatively cheap, low carrying-capacity grazing land. Hence, we find the important breeding centers located either in regions that are sparsely settled or in hilly areas where the land is too rolling to be farmed to advantage. Climate also plays an important part in determining the location of the breeding industry. The southern and southwestern states have a decided advantage over those farther north with respect to climate. Because of the shorter winters in these regions, the calves are ordinarily born 4 to 6 weeks earlier than in the north, or they may even be born in the fall. Thus the calves are larger and heavier when they are marketed the following fall.

The raising of beef calves is carried on most successfully on comparatively large farms or ranches, because little more labor is required

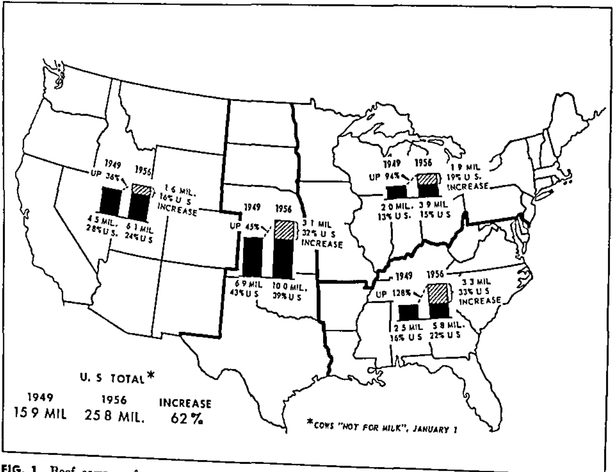

FIG. 1. Beef cows on farms and ranches in 1949 and 1956 Cow numbers more than doubled in the eastern half of the nation during this period. (U.S.D A.)

to care for a herd of 50 to 80 cows than for a herd of 10 to 20. So long as this country has extensive areas of government-controlled land or very low-priced grazing lands where large herds are cared for at the rate of only 1 man for each 500 cows, so long will the farmer who operates a quarter section of high-priced land find it unprofitable to engage extensively in breeding commercial beef calves for the open market. This statement does not mean that a breeding herd may not have a place on a great many farms. What is meant is that the breeding of commercial cattle necessarily will be of secondary importance to some other enterprise that utilizes more efficiently the available land and labor. On such farms the breeding herd is a sort of by-product plant in which the unmarketable products of the farm are successfully utilized.

Commercial—that is, not purebred—cow herds can be grouped together in four broad categories which depend upon system of land management, available feeds and pastures, and the method of marketing the calf crop, as follows:

(1) There are the large spectacular herds which sometimes consist of as many as a thousand cows or more, operated on ranches located principally in the Mountain region. These ranches usually consist of some deeded land situated along or near rivers or streams where the winter feed supply of hay or silage is produced on irrigated meadows and crop land. The remainder of the ranch usually consists of extensive acreages of low carrying-capacity, government-controlled land such as national parks or forests, which may be situated near or adjacent to the deeded land. The rancher has grazing privileges or permits for a given number of cows for the summer grazing season. The calf crop of this type of ranch is sold either as calves at weaning time in the fall, or as yearlings the following fall, after having spent another grazing season on the range. Little if any fattening is ever done on these ranches because grain is not grown to any extent.

(2) Then there are herds varying in size from 30 to 50 cows to very large herds operated on ranches usually owned by the rancher or leased from private owners. Most of these herds are found in the Great Plains and the Pacific Coast regions. The operation of these ranches varies considerably, depending upon whether they are located in the northern or southern portion of these regions and upon the feed-producing capabilities of the soil. Although most of these ranches sell either calves or yearlings to other ranchers or to feeders, some may feed out their own production. This practice is followed by more and more of the ranchers in the Southwest who are growing

grasses as orchard grass make it possible to reduce materially costly winter feeding. The climate is such that winter or very early spring calving is common, so that calves are weaned and sold earlier than the calves from the other areas. Those herds which do not market their production as fat slaughter calves or which do not feed out their calves as baby beeves usually sell as stocker or feeder calves rather than as yearlings.

Successful commercial cow and calf operations usually have several things in common regardless of the category into which they fall:

1. Relatively low investment in land required per cow.
2. Maximum utilization of pasture and low-sale-value roughages.
3. Minimum outlay for supplemental feed.
4. Low labor costs.
5. Large calf crops of high-quality, heavy-weight calves.
6. Minimal losses due to diseases and parasites.

Whereas the largest numbers of beef cows are found in the western and plains states, Fig. 1 indicates the extent of the greater increase in cow numbers in the eastern half of the country, notably in the southeastern states.

Stocker Program. A stocker is a young animal that is being fed and cared for in such a way that growth rather than an improvement in condition may be realized. Stockers or stock cattle are of two kinds: heifers that are intended for use in the breeding herd, and steers and heifers that are intended for the market as feeders or are intended for fattening by the present owner. With both kinds of stockers the principal purpose in the mind of the owner is to effect as much economy in feeding and management as is consistent with normal growth and development. Necessarily then, stockers are handled only by farmers or ranchers who have much cheap feed, either in the form of cheap pasture or cheap harvested roughage such as hay, straw, fodder, and silage. Since stock heifers that are intended for breeding purposes are in demand principally in the breeding centers where they have been produced, few animals of this class are to be found outside such areas. In general, their method of management is much like that of the breeding herd.

With stockers intended for the market, however, we have a somewhat different situation. Such cattle may be grown out in the region where they were bred and reared, by allowing them to graze grass land of the same character as that used by their mothers; or they may be shipped soon after they are weaned, either to grazing areas that are not fully stocked with cows and young calves, or to grain-

more grain sorghums and by those ranchers who have irrigation water available for the production of feed grains.

(3) Farm-sized herds of 20 to 100 cows are typically operated on farms in the Corn Belt and adjacent regions. On these farms commercial cows may or may not be a secondary enterprise. The beef cow herd often has replaced a dairy herd and sometimes tillable land incapable of maintaining high yields of cash crops has been seeded down to improved pasture which is utilized by a cow herd. In other instances, cows may utilize only the permanent pasture and aftermath and other cash-crop residues such as straw, cornstalk fields, and corn cobs. The production of these herds is usually either sold as calves in the fall or spring or the calves are fed out on the farms where they are produced. The large increase in beef cow numbers in the North Atlantic states consists of herds which also fall in this category.

(4) A fourth type of operation consists of herds varying in size from a few to several hundred cows, typically found in the Cotton Belt and Gulf Coast regions. These regions are in a very favorable situation with regard to the cow and calf program because long-season grazing is possible on pastures now occupying acres once depleted by erosion and continuous production of cotton, peanuts, sweet potatoes, or corn. Winter oats, fescue, and such long-season

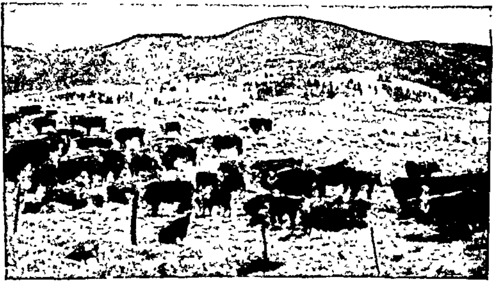

FIG. 2. A top-quality commercial cow herd with calves, on typical mountain foothill range in the Western Range area during early summer. (The Record Stockman.)

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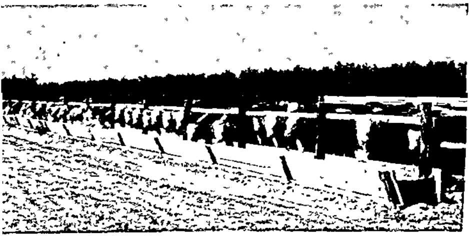
he Finishing Program. In some sections of the country the grass ufficiently abundant and nutritious to enable mature cattle to fat-on it without any additional feed. Most grazing areas, however, are heavily stocked that they furnish little more than a growing ration young cattle and make necessary the use of liberal amounts of vested feeds in finishing the cattle for market. The greatest pro-tion of such feeds is found in the Corn Belt, and it is here that we l the center of the cattle-finishing industry. Other important fin-ng sections are in the irrigated valleys of north central Colorado, ere the cattle are fed large quantities of sugar beet by-products,



. 4. Choice yearling steers on a finishing ration in northwestern Iowa. lter belt and board fence in background are sufficient protection from prevailing northwest winds. (American Hereford Association.)

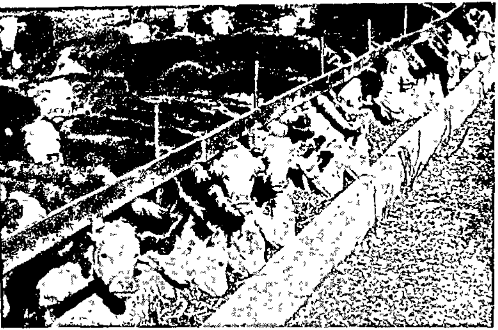


FIG. 3. Stocker steer calves being wintered on legume-grass silage in Indiana. These calves were born and raised to weaning age on a western ranch but will spend a year on this Corn Belt farm before being marketed as finished steers. (Corn Belt Farm Dailies.)

growing sections where they ultimately will be fattened. In grain sections their feed consists mainly of the aftermath of meadows, legume pasture crops grown in the regular farm rotation, stalk fields, oat straw, legume hay, and silage. Many cattle feeders of the Corn Belt make a practice of buying their cattle as calves or yearlings in the fall and carrying them on such feeds through the winter or for a full year before putting them into the feed lot. In this way the by-products of grain farming are utilized; any undesirable or unthrifty cattle are weeded out before the use of expensive feeds is begun; and, what is probably most important of all, the cattle are purchased when market conditions are particularly favorable to the buyer.

Stock cattle may be put in at almost any time of year on a well-diversified farm. Hence, an order for their purchase may be placed in the hands of a commission firm with instructions to buy when the next "big bargain day" occurs. On the other hand, cattle that are to go directly into the feed lot must be purchased within a rather short period, unless the plans for feeding and marketing are to be disarranged. It often happens that feeder cattle are selling unusually high at the time the farmer wishes to start his feeding operations. *Had he* bought his animals 3 to 6 months earlier, during a time of market de-

pression, and carried them along on rough feed until he really needed them, he might have effected a saving in the cost price of $1 to $5 per hundredweight.

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The Finishing Program. In some sections of the country the grass is sufficiently abundant and nutritious to enable mature cattle to fatten on it without any additional feed. Most grazing areas, however, are so heavily stocked that they furnish little more than a growing ration for young cattle and make necessary the use of liberal amounts of harvested feeds in finishing the cattle for market. The greatest production of such feeds is found in the Corn Belt, and it is here that we find the center of the cattle-finishing industry. Other important finishing sections are in the irrigated valleys of north central Colorado, where the cattle are fed large quantities of sugar beet by-products,

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a considerable distance from shipping points are able to reduce considerably their marketing expenses by marketing the products of their farms through cattle instead of in the form of hay and grain. Still another source of income from feeding cattle is the gain made by the hogs which are kept in the feed lot to utilize the grain that is not thoroughly masticated by the cattle and, hence, is only partially digested.

Cattle feeding, like other industries that derive their profits from buying raw materials and selling them several months later in the form of a finished product, involves some speculative risk. This risk is necessarily high when both cattle and feed are purchased, and the temptation is ever present to expand or contract operations according to the prospect of favorable or unfavorable prices for fat cattle in the future. However, in a regular, conservative feeding program that is adapted to marketing the feeds grown on a given farm, the risk is probably no greater than that connected with a number of other major farm enterprises.

The Baby-Beef Program. Strictly choice or better, fat, young cattle, varying in age from 8 to 15 months and weighing 650 to 950 pounds, are called "baby beeves." Baby beeves, like fat calves, represent a highly specialized form of beef production, quite different in many respects from that commonly followed in producing the rank and file of market animals. In finishing the baby-beef animal at so early an age, unstinted use must be made of palatable and highly nutritious feeding stuffs. Baby-beef production is carried on throughout the country wherever grain is grown, but naturally this program is concentrated in areas such as the fringes of the Corn Belt where grain is not only grown in large quantities but permanent pastures also play an important role.

Strictly speaking, the production of baby beef implies the breeding, rearing, and finishing of the calves on the same farm. Since only calves of strictly beef type exhibit a pronounced tendency to finish at so early an age, the breeding herd itself must exhibit those characteristics that signify early maturity and a pronounced disposition to put on flesh. Since mother's milk is a better fattening feed than any other yet devised by nature or man, the cows should be chosen with an eye to their milking ability. Grain is placed before the calves as soon as they are old enough to eat, which is usually when they are 4 to 6 weeks old. At no time during their short lives are they allowed to experience the feeling of hunger. Roughage occupies a minor place in the finishing ration because the calves have little capacity for quantities of roughage after consuming the desired

and in the tobacco- and truck-growing sections of the eastern states, where cattle feeding is carried on principally to obtain the manure needed to grow these high-profit crops successfully. Still other important cattle-finishing centers are the productive Mississippi Delta area in the South, the High Plains of the Texas Panhandle where much grain sorghum is grown, and the irrigated valleys in California, Arizona, and New Mexico.

A new development of increasing significance in the cattle-finishing program is the large-scale feedlot where mechanized handling of feeds makes for efficiency in this operation. These feedlots are located principally in the West Coast region and in the Southwest, where they are relatively close to both feeder cattle sources and feed supplies and not too far from increasingly important consuming centers.

In those sections of the Corn Belt where the land is somewhat rolling and where considerable pasture is available, the common method of finishing cattle is to feed corn on grass during the summer and fall months. Such sections often produce a small percentage of their supply of feeders; the balance is purchased from the western states. In the Corn Belt proper, however, where most of the land is tillable, the cattle are finished almost entirely on harvested feeds and the feeding is confined mainly to the winter months. A common practice is to buy, in the fall, yearling steers or heifers or heifer calves that are ready to go directly into the feed lot. They are accustomed to a full feed of grain as soon as possible and by April or May are usually carrying sufficient flesh to be satisfactory to the butcher. Cattle handled in this way interfere very little with the growing of crops. They arrive at the farm in the fall about the time the corn is harvested and leave in the spring before the busy season begins. On the other hand, many of the steer calves finished in the Corn Belt are carried well into the summer and fall, either in dry lot or on pasture. In the summer dry lot finishing program, more and more use is being made of "green chop"—rotation pasture forage which is chopped daily and fed fresh along with the concentrate portion of the ration.

The finishing of cattle for market has several important advantages in addition to the direct financial profit realized from the enterprise. One of the benefits is the fertility that remains on the farm in the manure. Farms on which cattle have been fed over a period of years are much more productive, as a rule, than adjoining farms where grain and hay have been sold. Cattle feeding offers an opportunity to utilize to advantage damaged grain and hay that would contribute very little to the farm income if sold for cash. Farmers located at

the majority of consumers in the rest of the country. Therefore consumer acceptance of this young milk-fed beef in the regions where it is produced is sufficient to insure acceptable selling prices.

Still more weight and condition are being added by creep feeding and earlier calving with many fall calves being dropped by cows on winter oat and wheat pastures. Three or more successive crosses with a beef bull may reduce the milk production of the mother cows unless careful attention is paid to this point. Calves from this program should by all means be marketed as slaughter calves, even if creep feeding is required to insure adequate finish or fatness. Once these calves lose their milk bloom they sell at a distinct disadvantage as stockers or feeders. This is so because, with age, their defects in beef conformation become more pronounced and the final selling price, after feeding in the manner usually used on straight beef-bred feeders, is considerably lower. Brahman bulls, which are in common use in the Gulf Coast region, sire calves which fit into the fat calf program very well.

Farmers throughout the country with small herds, who are trying to produce top-quality feeder calves, might give serious consideration to the fat calf program because ordinarily small herds do not result in a large enough volume of business to be profitable otherwise. This statement is especially true if the quality in the mother cows is not of the very best.

Fewer and fewer of the cows of the dual-purpose breeds such as the Milking Shorthorn and the Red Poll are milked and handled as dairy cattle. The more common practice is for most, if not all, of the cows to nurse their own calves until they are 8 to 10 months of age. Mature cows of good milking ability can easily nurse two calves and often extra calves are purchased, or calves from the cows which are milked are transferred to foster mothers. If labor is available calves are often housed in dry lot, apart from the cows, and turned in to nurse the cows twice daily. In this method of managing dual-purpose cows the calves learn to eat grain readily and the result is an ideal slaughter calf at weaning time, with extraordinary weights and still enough beef type to satisfy the most discriminating buyer of this type of slaughter animal.

Should milk prices shift to an extremely favorable position, the program can very easily be adapted to dairying provided strict attention has been paid to the inherent milk production in the replacement heifers On the other hand, if beef prices favor further feeding of the calves to the baby-beef stage, this feeding can be done economically because the calves are young and calves produced in these herds are

FIG. 5. Home-bred baby beeves, 16 months of age and almost ready for market as 1,000-pound slaughter cattle. These steers spent their entire lives on this Corn Belt farm. Note effective homemade feeding equipment. (Corn Belt Farm Dailies.)

amount of grain. However, the presence of the cow herd on the farm insures the utilization of all roughage materials.

The Fat Calf Program. Much of the increase in beef cow numbers in the southeastern states, and in the Corn Belt for that matter, can be attributed to the financial success achieved by those farmers who have adapted the cow and calf program to a set of circumstances peculiar to these areas. In the gradual shift from dairying, large numbers of dairy cows of all breeds are being bred to beef bulls. The resulting calves make very rapid gains due to the extra milk supplied by their dams. Coupled with this added milk is a longer lactation period. Calves weighing upwards of 600 pounds in slaughter condition are not uncommon at 8 to 9 months of age, and this increase is often made without grain feeding. Traditionally, consumers in the South and Southeast prefer beef with less finish than is desired by

Ranchers in the western states, where cattle are the principal source of income, have long recognized the value of purebred stock and have been willing to pay from $500 to $1,500 apiece for young purebred bulls to produce grade calves and yearlings to sell on the market. Farmers in the Corn Belt and elsewhere, however, who maintain small breeding herds as a minor enterprise, have been slow to recognize the importance of superior breeding. Too often they have been unwilling to pay more for a herd bull than the amount received for a fat steer at the market.

Despite the fact that there is a real need for large numbers of purebred bulls to serve as sires in both purebred and commercial herds, most purebred herds at present are not of sufficiently high quality to warrant saving over one-half to two-thirds of the bull calves dropped. Castration of such mediocre calves gives the purebred breeder a source of feeder steers which can contribute materially to his income in addition to raising the average quality of all commercial beef cattle. Purebred bulls and surplus breeding females must sell for substantially more than market prices before this program returns profits which warrant its operation.

Purebred heifers or cows are highly suitable as 4-H or FFA projects. Many a successful breeder started accumulating both knowledge and a foundation herd in his youth with the purchase of such a female.

FIG. 7. A purebred Angus herd on a productive Iowa farm. Purebreds, if high enough in quality, may be used to increase volume of business without increasing numbers. (American Angus Association.)

FIG. 6. Native grade cows with their 600-pound milk-fat calves ready for slaughter. These calves, sired by a registered Hereford bull, were dropped in January and February and sold for slaughter at weaning time in October. (University of Kentucky.)

traditionally good gainers. It is doubtful, however, if feeding to heavy weights and a high degree of finish is advisable, because faults in beef conformation become more apparent with age, as in the dairy-beef crosses mentioned earlier.

The Purebred Program. The breeding of purebred or registered cattle is a highly specialized form of beef production. Because of the relatively large amount of capital required for animals and equipment, and because of the skill and sound judgment that must be possessed by the manager before success is possible, this phase of cattle breeding is one better suited to men of considerable experience than to beginners. It should, however, be the ultimate goal of a large number of breeders, particularly if it is to be carried on in connection with the production of the highest type of cattle for the open market.

The opportunities offered the breeder of purebred cattle are almost unlimited. Honor, fame, and large financial rewards are all within the possibility of realization. The purebred cattle business in this country, large though it is, is still in its youth. That great strides will be taken in its expansion during the future is scarcely to be doubted.

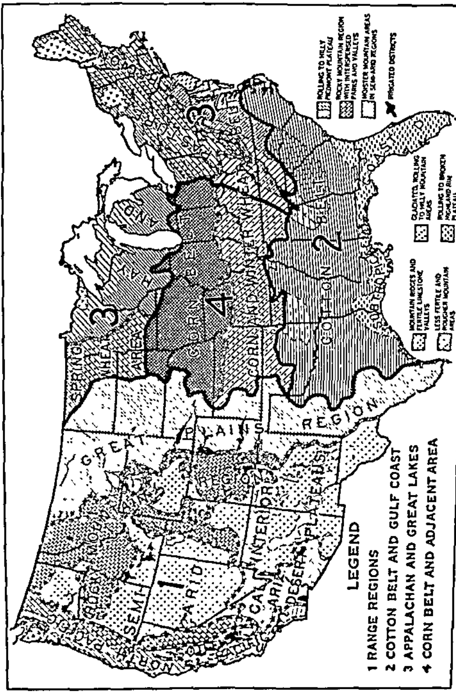
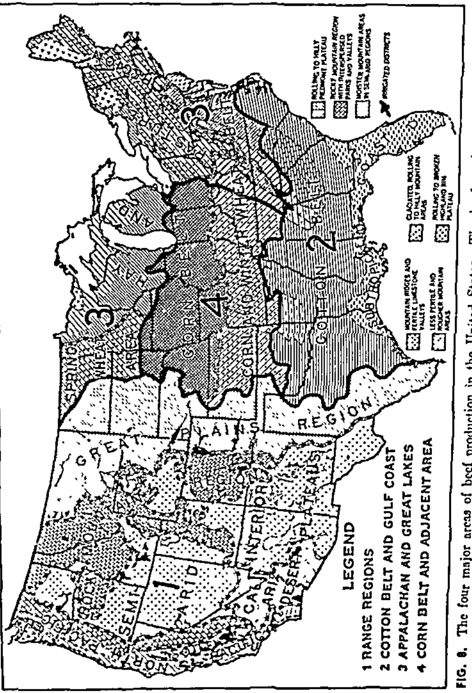


FIG. 8. The four major areas of beef production in the United States. The beef cattle program used in each area is determined largely by the feed supply and the climate. (U.S.D.A.)



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Although purebred beef cattle have increased noticeably in the Corn Belt and in the southeastern states in recent years, they have not kept pace with the increase of commercial beef cows in these areas. When it is considered that probably not over half of the grade beef cows of these regions are now bred to purebred bulls and that probably a similar proportion of the purebred beef bulls now used in grade herds are of mediocre merit, the future demand for young purebred bulls with production records or with progeny-tested sires appears unusually bright. Purebred herds in the western part of the Corn Belt are still the source of supply for many bulls for the Western Range, whereas the purebred breeders of Illinois, Indiana, and Ohio will be called upon more and more to supply large numbers of purebred males and females for the rapidly expanding beef cattle industry of the South.

AREAS OF BEEF PRODUCTION[1]

Four rather well-defined areas of beef production exist in the United States. Each differs from the others in the extent to which beef production is carried on and in the relative importance of the various phases of management that have just been discussed. Obviously each of these areas may be divided into still smaller regions, each of which is noted for some particular phase of cattle raising or for some rather unusual method of handling its cattle. However, no attempt will be made to indicate these smaller subdivisions, inasmuch as interest in them is largely local.

The Western Range. The Western Range consists roughly of that area lying west of the one-hundredth meridian. This area may be further divided into the Great Plains region, the Rocky Mountain region, the Pacific Coast region, the American Desert region, and certain smaller sections of more or less local importance. (See Fig. 8.)

In this area the breeding of calves and the growing out of young cattle on grass are the dominant phases of beef production. Owing to the great amount of grazing land, some of which is still public domain, this region is particularly well suited for these extensive, rather than intensive, forms of cattle raising. Although some of the more mature steers have sufficient flesh when removed from grass in the fall, to make them acceptable for immediate slaughter, the majority of the cattle are sold as feeders for further finishing.

Inasmuch as beef production is a major enterprise with a majority

[1] U.S.D.A. Yearbook, 1921, p. 243.

California, western Texas, Arizona, and Washington are areas which show particularly large increases in numbers of beef cattle fattened. In fact, the western states feed about 3 to 4 times more cattle now than just before World War II. California shows the greatest change with a sevenfold increase. Naturally this all means that Corn Belt feeders get real competition for feeder cattle from the western feeders.

The Corn Belt and Adjacent Region. This area is noted for its broad stretches of prairie land and its exceedingly fertile soil. Hence it is a region devoted largely to the growing of crops. Because of the high price of land we find rather small to medium-sized farms, which are devoted largely to general farming but on which grain growing occupies the place of major importance. Intensive rather than extensive methods of husbandry prevail.

Beef production under such conditions necessarily assumes quite a different role from that which it plays in the Western Range area where land is relatively more plentiful and cheaper. It, too, is carried on

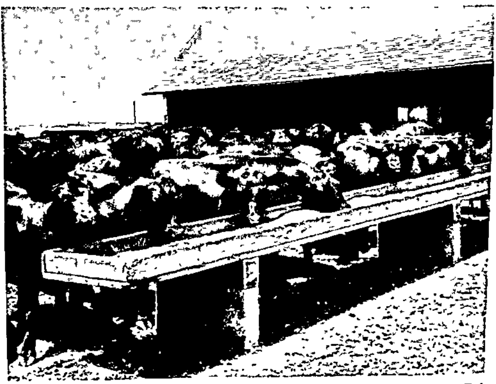

FIG. 10. Prime, long-fed steers which have been on full feed in a Corn Belt feed lot for about 10 months after having been bought in the Nebraska Sandhills as weanling calves the previous fall. (American Angus Association.)

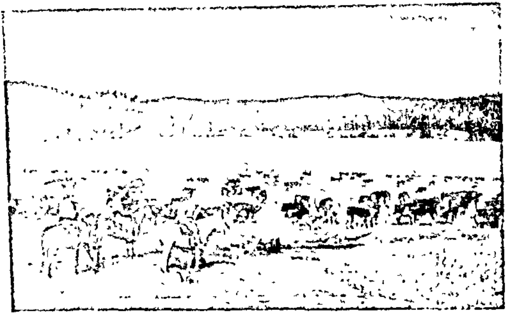

FIG. 9. A commercial cow herd is the major enterprise on this Oregon ranch on the *western slope of the Rocky Mountains. Yearling replacement heifers,* being bred to calve as 2-year-olds, may be seen in the herd. (The Record Stockman)

of the ranchers of this area, we find the cattle well bred and handled according to modern methods of ranch management.

Formerly most of the purebred bulls used in improving the type and quality of the range cattle were purchased from Corn Belt breeders, but at the present time a large percentage of the bulls used in the range area are bred there. In fact, breeding good bulls for sale to commercial ranchers, as well as breeding superior young bulls and heifers to go into other purebred herds, is now a highly important phase of beef production in the Western Range states.

Until the years following World War II, the ranchers in the Western Range area fattened few cattle, preferring to ship most of their calves and yearlings to the Corn Belt. This practice has changed materially. Four principal factors responsible are:

(1) Higher freight rates on shipment of live cattle to Corn Belt markets and of dressed beef back to consuming centers in the West.

(2) Substantial disproportionate increases in consumer population in the western states.

(3) Simultaneous increase of irrigation facilities and development of high-yielding grain sorghum varieties that could be combine harvested.

(4) Development of large-scale feedlot operations.

Table 1

LEADING STATES IN THE PRODUCTION OF VARIOUS BREEDS OF PUREBRED CATTLE

States in Which Largest Number of Calves Were Registered in 1956

Rank	Angus	Brahman	Hereford	Polled Hereford	Shorthorn and Polled Shorthorn*
1	Missouri	Texas	Texas	Texas	Illinois
2	Iowa	Florida	Oklahoma	Missouri	Iowa
3	Illinois	Louisiana	Kansas	Illinois	Indiana
4	Texas	California	Nebraska	Mississippi	Missouri
5	Kansas	Arkansas	Montana	Oklahoma	Ohio
6	Kentucky	Alabama	Missouri	Kansas	Kansas
7	Oklahoma	Georgia	Illinois	Georgia	Nebraska
8	Virginia	Arizona	South Dakota	Tennessee	North Dakota
9	Indiana	North Carolina	Colorado	Arkansas	Kentucky
10	Ohio	Mississippi	California	Indiana	South Dakota

* Sept. 1, 1956 to Sept. 1, 1957.

beef cattle. The former makes possible low costs of production, and the latter insures a broad market for all surplus breeding stock.

The Appalachian and Great Lakes Region. This region is noted for its rolling topography, which in places assumes a mountainous character. Under such conditions permanent pastures and woodlands naturally occupy a considerable portion of the total area As always in broken regions, wide variations exist in the character and fertility of the soil. In certain sections there are extensive outcrops of limestone on which the best bluegrass of the country is found. Grass grown on such a soil is exceedingly nutritious and is valued highly by cattle grazers. Such areas are usually stocked with older steers, which fatten satisfactorily during the summer on this grass alone. In other areas of this region the soil is very thin and produces only a scanty growth of grass and weeds of inferior feeding value. These areas are used mainly by breeding herds or by young stocker cattle that have been purchased in the West or South. At the end of the grazing season these stocker cattle are either fattened on feeds grown on the bottom land or are held over for another summer and wintered on hay or silage.

Despite the predominance of dairy and dual-purpose cattle in the Appalachian and Great Lakes region, beef cattle have increased noticeably in numbers there since the mid-1930's. Especially is this true

according to intensive rather than extensive methods of management. The finishing of western-grown, and in increasingly more cases, southern-grown cattle, either in dry lot or on a limited amount of pasture, represents the typical method of handling cattle in the Corn Belt and adjacent region. As a rule the cattle are bought in the fall at public stockyards, feeder cattle auctions, or direct from the range. Yearlings are commonly allowed to run on pastures and stalk fields for 3 or 4 weeks, at the end of which time they are confined in dry lots and placed on a fattening ration. Normally 5 to 7 months are required to make satisfactory market bullocks out of these yearlings, though many feeders make no attempt to finish their cattle, shipping at the end of what is termed a "short feed" of 90 to 100 days.

Summer feeding on grass of overwintered calves is the method commonly followed in sections that are somewhat rolling though tillable, and therefore have large areas in both rotation and permanent pasture. This program is by no means restricted to rolling land in the Corn Belt, however; in fact, this type of calf program is slowly but surely increasing in importance on the level, most productive land. Because of the scarcity of thin cattle in the spring, steers that are to be fed on pasture are often bought in the fall and carried through the winter as stockers on such feeds as hay, silage, and a low level of concentrates, which tend to produce growth rather than fat. Thus, two phases of beef production are represented in such a method of management.

Cow and calf operations in the Corn Belt, although smaller in number than they were at the beginning of the twentieth century, are still of more importance than is commonly supposed. The fact that most of the native calves are raised and fed in small groups of 5 to 20 head makes the breeding industry less spectacular than the feeding of shipped-in cattle The latter are frequently handled in droves of 50 to several hundred. Nevertheless, fully two-thirds of the cattle and calves normally slaughtered within the Corn Belt or shipped from there to central markets are native cattle which have been bred in this region Whereas a considerable portion of these cattle are discarded dairy cows and veal calves, a large number are young cattle of beef and dual-purpose breeding which are marketed as fat yearlings or as baby beeves.

Another aspect of breeding operations in the Corn Belt is the raising of purebred cattle This region, because of its abundant feed supply and its proximity to the Western Range and the Cotton Belt areas, enjoys particularly favorable conditions for the raising of purebred

in land and buildings, the short, mild winters and long growing seasons, and the vast multitude of forage and pasture crops that can be grown successfully. The increased production of winter oats, corn, and most of all, the newer hybrid grain sorghums of both the forage and grain types is making this region a real competitor as a cattle fattening area. Demonstrated proof of the superior adaptation of the Brahman breed and its crosses in the hotter, more humid portions of this area has been responsible for much of the increase in cattle numbers. The application of soil conservation and soil-building practices which were encouraged by government crop control programs, the improvement of pastures, and the production of more adapted forage crops come in for their share of credit. It will be very surprising if this region does not continue its rapid expansion in all types of beef production programs. The South is the logical place to look for that expansion in beef production which must occur if the growing demands of an ever-increasing population are to be met. Table 2 shows that the beef cattle population of the South has been increasing at a faster rate than that of any other section of the country.

FIG. 12. Many cotton plantations and farms in the Gulf Coast region have been sodded with Coastal Bermuda and other adapted perennial grasses. Brahman cattle or Brahman crosses are popular in this region because of their adaptation to the environment (National Cottonseed Products Association, Inc.)

FIG. 11. One of the many new cow herds in Virginia, being used to utilize the *improved pastures which have displaced cash crops from these rolling hills.* (American Angus Association.)

in Wisconsin, Michigan, Maryland, and the Virginias. Many farms and plantations in these states, which formerly produced principally dairy products, truck, cash grain crops, or tobacco are now largely in grass utilized by beef cattle. Many excellent purebred herds of beef cattle have been established in these areas and are a source of improved breeding stock for their rapidly expanding beef industry.

The Cotton Belt and Gulf Coast Region. Except for the two states of Texas and Oklahoma, the Cotton Belt and Gulf Coast region has not been an important beef-producing area until recently. As a rule few cattle were found on each farm and often these were noticeably lacking in type and quality.

Rainfall is highly variable in the eastern part of this region, and drought is rather common farther west. The result is a rather undependable pasture situation. Winter feed supplies are sometimes rather expensive and poor in quality as a consequence of this lack of a dependable moisture supply. Once-productive, tillable soils devoted to the growing of cotton and other cash crops are in all too many instances both badly eroded and depleted of soil nutrients. Consequently, either production of forage is low, or investment in fertilizers is high. Wet weather during the wintertime in parts of the area makes grazing of winter oats and tame pastures difficult during some years and adds still further to the uncertainty of the winter feed supply.

Offsetting these disadvantages are the relatively low investment

The Beef Cattle Cycle. A study of the fluctuations in the cattle population of the United States over a series of years discloses that these fluctuations have not been haphazard but have followed a rather regular order. Periods of large cattle numbers have occurred about every 14 to 16 years. Likewise, periods of unusually low numbers of cattle have been separated by about the same interval. (See Fig. 13) Since price is a function of supply, it follows that approximately the same time intervenes between periods of very high prices or between periods of very low prices—namely, about 15 years. This interval of time, which is called "the cattle cycle," is much used by agricultural statisticians and market forecasters in predicting the supply and price of cattle in the immediate future. A livestock marketing specialist has described the evolution of a typical cattle cycle as follows:

Briefly, a typical cycle begins with an increased demand for breeding stock to expand herds. Prices of breeding stock soar and the producing (cow-and-calf) enterprise becomes especially profitable. As cows, heifers, and calves are held back, only steers are marketed in large numbers for slaughter. Later when calves from enlarged breeding herds reach maturity, total slaughter increases. Prices break, often severely. Declines are sharpest for breeding stock, and least for high grade fed cattle. The producing enterprise becomes relatively unprofitable, more cows are slaughtered, and a scramble ensues to expand the feeding business. Both cow and calf slaughter are larger, cow herds are reduced, and the calf crop becomes smaller. Ultimately total slaughter decreases and prices turn upward, initiating a new cycle.

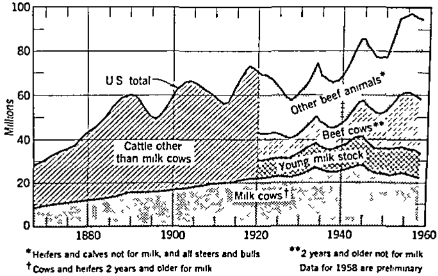

FIG. 13. Cycles in beef cattle numbers, 1865–1958 It will be noted that "peaks" in cattle population have occurred about every 15 to 16 years, but cycles are apparently becoming somewhat shorter (U.S.D.A.)

Table 2

RELATIVE GROWTH IN BEEF COW AND TOTAL CATTLE NUMBERS IN DIFFERENT TYPE-OF-FARMING REGIONS*

Type-of-Farming Region	1949	1956	Percentage Increase 1949–1956	Rank in Increase
	1,000	1,000	%	
		Beef Cows		
North Atlantic	54	141	161	1
Lake	222	496	123	4
Central Corn Belt	1,719	3,241	89	6
Northeastern	1,995	3,878	94	
Appalachian	613	1,429	133	2
Southeastern	980	2,164	121	5
Delta	951	2,202	132	3
Southeastern	2,544	5,795	128	
Northern Plains	2,946	4,756	61	7
Southern Plains	3,969	5,252	32	9
Plains	6,915	10,008	45	
Mountain	3,410	4,434	30	10
Pacific	1,055	1,643	56	8
Western	4,465	6,077	36	
United States	15,919	25,758	62	
		All Cattle and Calves		
North Atlantic	5,140	5,607	9	10
Lake	8,646	10,326	19	8
Central Corn Belt	14,567	18,956	30	4
Northeastern	28,353	34,889	23	
Appalachian	5,671	7,120	26	5
Southeastern	3,622	5,747	59	2
Delta	3,697	5,950	61	1
Southeastern	12,990	18,817	45	
Northern Plains	11,562	14,617	26	5
Southern Plains	10,438	11,830	13	9
Plains	22,000	26,447	20	
Mountain	8,776	10,775	23	7
Pacific	4,711	6,537	39	3
Western	13,487	17,312	28	
United States	76,830	97,465	27	

* Compiled from U.S.D.A. *Agricultural Statistics*, 1949 and 1956

chapter 2

THE RELATIONSHIP OF BEEF CATTLE TO OTHER FARM ENTERPRISES

For the farmer who makes a practice of growing a variety of crops and who divides his time between grain and animal production, beef cattle possess some advantages over other kinds of livestock. Some of these advantages are of sufficient importance to warrant their analysis and discussion. Attention should be called to the fact that some of the data cited in support of certain statements are based on all cattle—both beef and dairy. Unfortunately, available statistics do not permit an accurate separation of these two types for making some highly desirable studies. The advantages of beef cattle are discussed briefly in the next few pages.

Cattle Utilize Large Quantities of Roughage. Any system of general farming produces a large quantity of coarse, low-grade roughages that have a very low market value. In the common 4-year Corn Belt rotation of corn, corn, oats, and clover, approximately 1¾ tons of roughage are produced for every ton of grain secured. Of this roughage, that resulting from the corn crop is practically unsalable, and the oat straw and clover hay are often hard to dispose of at remunerative prices, especially if damaged slightly by rain or by the presence of weeds. All these roughages, when properly fed, constitute good feed for beef cattle and, on the average, return more to the farmer when fed than when sold on the market.

At the present time large quantities of corn stover are allowed to go to waste which, if properly stored and fed, would support millions of beef cows and stocker cattle during the long winter months. The annual production of both straws and stover in the United States is enormous, being nearly 175,000,000 tons. When this amount is compared with the total production of wild and tame hay—100,000,000 tons—the importance of the roughages that are by-products of grain

Having located our place on "the cycle" with reference to the last "peak" or "low spot," we need only construct that part of the curve which represents the next 5 or 6 years to see what supply and price changes are likely to occur during that period. However, it should be pointed out that the price of cattle is not determined by the cattle population but by the number of cattle which are marketed and by *the consumer demand for beef. Consequently, any event that changes* either of these factors has far more effect upon cattle prices than does the total number of cattle in the country. For example, the severe droughts that were experienced on the Range and in the Corn Belt during 1934 and 1936 resulted in a sharp reduction in the number of cattle after only 5 or 6 years of expansion, instead of the usual 7 or 8. The decline in numbers was abnormally severe but was of short duration because of the onset of World War II. The heavy demand for beef by both military and civilian consumers during the war resulted in the concurrent rise in cattle numbers and cattle prices, whereas normally, when numbers increase, prices fall. Hence the cattle cycle may be greatly disturbed by unforeseen abnormal conditions. For this reason it should not be followed blindly but should be regarded as a very rough guide in planning a cattle enterprise on an individual farm. There is evidence that the number of years required for the build-up to the peak of the cattle cycle has become less with each cycle, or, in other words, the build-up is at a faster rate than formerly.

Table 5

CORN HARVESTING METHODS AND UTILIZATION IN VARIOUS GROWING AREAS*

(Average for 1949–1951)

Geographical Area	Acreage Harvested (1,000 acres)	Percentage of Crop: Harvested for Grain (per cent)	Percentage of Crop: Harvested for Silage (per cent)	Percentage of Crop: Hogged, Grazed, or Green-Chopped (per cent)	Yield per Harvested Acre, (bushels)	Estimated Stover from Acreage Harvested for Grain† (1,000 tons)	No. of Cows Which Could Be Wintered on Stover‡
Corn Belt	31,471	95.9	2.1	2.0	48.7	53,500	13,375,200
Great Plains	14,809	86.2	3.6	10.2	27.7	14,204	3,566,200
Lake	9,663	73.2	22.3	4.5	42.3	14,491	3,623,500
Appalachian	7,733	95.7	1.8	2.5	34.7	9,279	2,319,900
Southeast	7,674	87.0	0.4	12.0	18.1	4,835	1,201,600
Okla.-Texas	3,578	90.8	0.7	2.5	20.4	2,530	632,500
United States	82,908	89.1	5.7	5.2	37.1	107,780	26,915,000§

* U.S.D.A. Statistical Bulletin 129, *Harvesting Corn for Grain*, June, 1953.

† Assuming 70 pounds of stover per bushel of corn produced.

‡ Allowing 4 tons of corn stover per cow for winter period.

§ Total beef cows 2-years-old and over in United States, Jan. 1, 1950—25,758,000.

Table 3

SOURCE OF ALL FEED FED DIFFERENT CLASSES OF LIVESTOCK*
(Average 1950–1955)

Item	Beef Cattle (%)	Dairy Cattle (%)	Hogs (%)	Sheep (%)	Poultry (%)
Corn	10.5	10.4	63 5	3.9	39.6
Other grains	1.4	7.4	16.0	1.5	27.2
Commercial by-products	4.8	7.4	12.7	1.9	30.5
Seeds and skimmilk	0.2	1.5	3.1	—	0.5
Hay	14.6	28.9	—	12.1	—
Silage and stover	6.7	9.6	—	3.1	—
Pasture	61.8	34.8	4.7	77.5	2.2
Total	100.0	100.0	100 0	100.0	100.0

* U.S.D.A. Statistics.

production is realized. In the Corn Belt area, where a system of general farming is the rule, the percentage which stover and straw constitute of the total roughage supply is even more important than for the country as a whole. A comparatively small amount of this vast quantity of roughage is used efficiently in this area, as is indicated by Tables 4 and 5.

Table 4

ESTIMATED PRODUCTION OF CEREAL STRAW AND PERCENTAGE USED*

Geographical Area	Estimated Production of Straw, 1945	Left in Field as Stubble, Chaff, and Short Straw from Combines	Recoverable for Use on Farms or for Sale	Recoverable Straw That Was: Used on Farm or Sold	Recoverable Straw That Was: Left in Field or Otherwise Not Used
	1,000 tons	1,000 tons	1,000 tons	Per cent	Per cent
Corn Belt	23,038	9,707	13,331	66.6	33.4
Lake	17,397	5,174	12,223	78.5	21.5
Great Plains	49,189	22,064	27,125	25.7	74.3
Oklahoma-Texas	11,131	5,754	5,377	15.8	84.2
United States	134,518	58,112	76,406	45.1	54.9

* U.S.D.A., Harvesting Small Grains and Utilization of the Straw, F. M. 66, June, 1947.

Table 6

IMPORTANCE OF PASTURE IN GENERAL FARMING AREAS*

	Average Pasture Acreage per Farm			Percentage of Total Farm Area in Pasture		
	Crop Land Used Only for Pasture (acres)	Woodland and Other Pasture (acres)	Total Pasture (acres)	Crop Land Used Only for Pasture (%)	Woodland and Other Pasture (%)	Total Pasture (%)
Illinois	11	27	38	7	18	25
Indiana	10	24	34	10	23	33
Iowa	7	40	47	4	25	29
Missouri	21	52	73	15	35	50
Ohio	8	28	36	9	28	37
Middle Atlantic states	4	29	33	4	29	33
East North Central states	10	30	40	8	25	33
West North Central states	10	101	111	4	37	41
United States	8	98	106	4	51	55

* Compiled from U. S. Census of Agriculture.

tures, and livestock production reach their highest state of development. Beef cattle make it possible for the permanent and rotation pastures to contribute a fair share of income on the farms in this vast area.

In less favored parts of the country, real efforts are being made to reclaim and rebuild soils no longer able to support cash crops. However, *without beef cattle and other ruminants to convert the grass* and roughage produced on these lands into income, such reclamation is economically impossible.

Pastures necessarily occupy a large portion of the total farming area in this country. Contrary to the opinion held by some, permanent pastures have by no means disappeared in the Corn Belt and other farming areas, nor is it at all likely that they ever will, because even in the Corn Belt an appreciable area of land is better suited for pasturage than for anything else. To this permanent pasture must be added the acreage of temporary pasture crops such as winter small

A more efficient utilization of all farm products is one of the important problems of the general farmer. With these coarse roughages beef cattle offer a solution that is usually found satisfactory. Mature beef cows can be maintained satisfactorily on rations composed of roughage alone, whereas steers that are being finished for the market consume 50 to 300 per cent as much roughage as grain, depending on the degree to which their grain ration is limited. Illinois studies[1] summarizing the cost account data obtained from a typical cattle feeder in western Illinois over a period of 7 years show that the ratio of roughage to concentrates fed was 141 to 100.[2] Thus it is seen that beef cattle are well adapted to utilize the surplus roughages that are produced under a system of general farming.

Cattle Utilize Pasture Crops. The importance of pastures and the place of beef cattle in their utilization upon ranches is taken for granted. On the contrary, the importance of pasture crops in the nonranching areas of the country is often overlooked. In the more important general farming areas of the country, namely the Corn Belt and the Middle Atlantic States to the eastward, grain farming, pas-

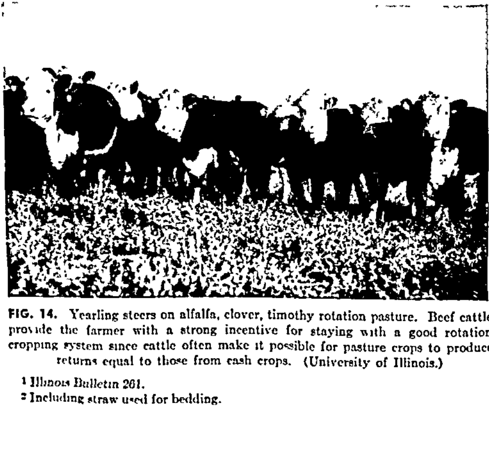

FIG. 14. Yearling steers on alfalfa, clover, timothy rotation pasture. Beef cattle provide the farmer with a strong incentive for staying with a good rotation cropping system since cattle often make it possible for pasture crops to produce returns equal to those from cash crops. (University of Illinois.)

[1] Illinois Bulletin 261.

[2] Including straw used for bedding.

Table 8

ESTIMATED GRAIN AND PROTEIN CONCENTRATE REQUIREMENT FOR BEEF CATTLE

(For feed year September 1, 1956 through August 31, 1957)*

Class of Beef Cattle	Grains and Mill Feeds			Protein Concentrates	
	Number (1,000)	Required per Head (lb.)	Total Requirement (1,000 tons)	Required per Head (lb.)	Total Requirement (1,000 tons)
Cows	24,900	90	1,120	75	934
Yearling fattening heifers	2,200	1,200	1,320	100	110
Other yearling heifers	4,000	125	250	100	200
Yearling fattening steers	*6,000*	*1,500*	*4,500*	*125*	*375*
Yearling stocker steers	3,500	60	105	125	219
Bulls	1,200	250	150	75	45
Fattening heifer calves	4,000	1,200	2,400	90	180
Other heifer calves	5,100	200	510	90	230
Fattening *steer calves*	*5,100*	*1,800*	*4,590*	*200*	*510*
Stocker steer calves	5,000	200	500	90	225
Total			15,445		3,028†

* Estimates made by Feed Survey Committee for the American Feed Manufacturers' Association.

† Protein concentrates expressed as soybean oil meal equivalent based on 40.0% crude protein content.

Since such a large percentage of the grain grown in the United States is fed to livestock, its feeding must return a reasonable profit, even to the marginal feeder, if the price of grain is to be high enough to cover the costs of growing it. If the marginal feeders lose money on their cattle and hogs, a large number drop out and sell their corn, with the result that corn prices fall sharply the following year because of the increased supply and the decreased demand. Thus it happens that unsatisfactory prices of cattle and hogs for the livestock farmer quickly bring about unsatisfactory prices of grain for the cash grain farmer. This situation can always be expected as long as livestock furnishes the principal market for the grain farmers' product.

grains, timothy, red and sweet clover, sudan grass, and various mixtures of grasses and legumes, most of which are grown as a part of the regular farm rotation. Thus it is not surprising that the total pasture area is considerable, even in the major Corn Belt states.

Cattle Furnish a Home Market for Grain and Hay. *Excepting* wheat, comparatively little of the immense supplies of grain and hay produced in this country is used other than as feed for farm animals. The great bulk of these feed materials is used on the farms where it is produced. Of the remainder that is sold, the larger portion is bought by feeders who do not raise enough to supply their own needs. Even in the heart of the Corn Belt considerably more than 60 per cent of the grain and hay is fed on the farms where it is grown.

No one will deny that beef cattle constitute an important home market for these farm-grown feeding stuffs. For the United States as a whole, beef cattle consume 11 per cent of the 3-billion-bushel corn crop. For the Corn Belt section this percentage is very much higher, since corn is the principal feed used in the extensive fattening operations carried on in this region.

Grain growers, instead of seeking new foreign outlets or new uses for their grain in industry in order to increase demand and thus secure a higher price, could, as a rule, use their efforts to better advantage by encouraging the feeding of more livestock.

Table 7

PERCENTAGE OF FEEDS CONSUMED BY DIFFERENT KINDS OF LIVESTOCK*
(Average 1950–1955)

	Corn				
	Excluding Corn in Silage (%)	Including Corn in Silage (%)	All Concentrates (%)	All Roughage Including Silage and Pasture (%)	All Feeds Including Pasture (%)
Beef Cattle	13.2	19.0	12.4	47.5	32.6
Dairy cattle	14.8	15.5	18.5	38.1	29.6
Sheep and goats	0.7	0.7	0.7	6.8	4.2
Hogs	45.7	41.5	36.2	1.8	16.5
Poultry	18.6	17.0	25.3		11.0
Horses and mules	3.0	2.7	2.9	5.6	4.3
Other livestock	4.0	3.6	4.0	0.2	1.8
Total	100.0	100.0	100.0	100.0	100.0

* R. D. Jennings, *Consumption of Feed by Livestock*, 1909–1955, U.S.D.A. Production Research Report.

Table 9

MONTHLY EXPENDITURE OF LABOR IN FEEDING BEEF CATTLE*

	Labor Expended	
	For Cattle (hr.)	For Total Farm (hr.)
January	164	511
February	144	496
March	132	718
April	79	916
May	31	1,000
June	—	1,133
July	—	1,370
August	—	889
September	1	934
October	13	815
November	78	825
December	129	648
Total labor per year	771	10,255
Labor, Nov. 1 to April 1	647	3,198
Per cent of labor coming *in fall and winter*	*83.8*	*31.2*

* Illinois Bulletin 261

the employment of an extra man during the spring and summer under a grain system is frequently operated by the owner alone under a livestock system in which beef cattle predominate. Moreover, the cattle furnish many hours of profitable employment for the owner and his tractor during the winter, which without cattle would be spent largely in idleness.

The attention of the reader is called to Table 9, which shows the average monthly expenditure of labor on a 295-acre Corn Belt farm on which 40 to 79 cattle were fed annually over a 7-year period. Had cattle feeding not been included in the system of farming, it is likely that only a small fraction of the 647 hours of labor expended during the winter months would have gone into remunerative enterprises. The returns realized from this labor, therefore, may be counted as an almost clear gain to the farm income.

Beef Cattle Entail Little Death Risk. Beef cattle enjoy an advantage over most other forms of livestock in that they are subject to few ailments and diseases that are likely to have a fatal termination. Compared with sheep and hogs, beef cattle have an unusually low death rate They are subject to no disease at all comparable with hog

Beef Cattle Utilize Cash Crop By-Products. The oilseed meals resulting from the processing of soybeans, cottonseed, and flax compose the major portion of the protein concentrates which are fed to beef cattle to balance their rations. Wheat bran, peavine silage, blackstrap molasses, rice hulls, beet pulp, citrus pulp, cannery waste, and cottonseed hulls are other important examples of the by-products of milling and processing farm crops that are used in beef cattle rations.

Prices received by farmers for crops from which these by-products are made are increased owing to the large quantity of such by-products consumed by beef cattle as well as by other farm animals. The total by-product production of at least 5,000,000 acres is fed to beef cattle.

Beef Cattle Require a Small Investment in Buildings and Equipment. The average investment in buildings and equipment per hundred dollars invested in livestock is lower for beef cattle than for other farm animals. Although new building costs have advanced greatly during the past few years, they have not advanced nearly so fast as the value of beef cattle. Moreover, many of the shelters and feed yards in use 30 or 40 years ago are still being used today and, therefore, no longer have a claim to an annual interest and depreciation charge

The equipment charge made against the breeding herd is very low, amounting on many farms to less than $5 per cow per year. Equipment used in the cow and calf program consists mainly of shelter, fences, headgates, feed troughs, and water tanks. None of these need be of expensive construction They are frequently built by the farmer himself at odd times when he has little else to do.

Increased use of pole-type barns and open sheds instead of conventional barns, or the elimination of barns and sheds entirely, along with cheaper bunker-type or trench silos, has lowered the relative cost of buildings still further. Partially offsetting this decrease is the greater expense of some of the labor-saving feed handling, mixing, and storage facilities.

Beef Cattle Assist in Utilizing Labor. Beef cattle require little labor compared with dairy cattle and hogs, or with cultivated crops occupying an equal area of land. Of the labor that is required, the larger part is needed during the winter and early spring when there is little demand for labor in the fields. Thus beef cattle tend to distribute the labor requirements of the farm throughout the year by (1) utilizing labor that otherwise would be unemployed during the winter, and (2) lessening the summer demand for labor by using part of the tillable land for hay and pasture. A farm that would require

Beef Is the Most Popular Meat. A continuing shift in meat consumption from pork to beef is ample evidence of the overwhelming popularity of beef. During the 15-year period of 1940–1955, total annual meat consumption increased by about 20 pounds per person in the United States. The 25-pound-per-person increase in beef consumption, as shown in Table 10, is more than enough to account for the total increase.

DISADVANTAGES OF THE BEEF CATTLE ENTERPRISE

A Speculative Risk Is Involved in Finishing Programs. In periods of rapidly declining prices the real possibility exists that finished cattle may sell for less per hundredweight than the original feeder cost. This possibility of course applies only directly to the original weight bought, and this situation has occurred only about one year in ten. In some of the finishing programs, especially those involving either heavy or low-grade feeders, the selling price may also be below the actual cost of the gains or, in other words, after conversion to cattle gains, the feeds consumed by such feeder cattle may sell for less than their market value.

Annual Outlay of Capital Is High in Finishing Programs. Most cattle feeders have to buy their stockers or feeders and, since such cattle often remain on the farm or in the feed lot for over a year, it is necessary annually to invest as much as one-third to two-thirds of the final value of the finished cattle aside from the investment in feed. This amount requires a rather large supply of either available cash or credit, and interest charges on this large investment must be reckoned with.

Beef Cattle Programs Require Labor and Management of Above Average Quality. In order to keep costs down and disease and death losses low, and in order to make use of the latest research findings in the feeding and management of beef cattle, skilled labor is required. This skilled labor is possibly even more necessary if the buying and selling of cattle are not turned over to a commission man or order buyer who is especially trained to do this job. Knowing when fed cattle are ready to sell to best advantage prevents the costly gains that result when cattle are held beyond the point at which they are finished for their grade. Choosing the proper feeding program to utilize the available feed supply, and the adaptation of the program to take advantage of seasonal trends in supply of both feeders and fed cattle, are likewise of the utmost importance. Because of the significance of decisions such as those mentioned above, managerial ability is essen-

chapter 3

BEEF CATTLE AND SOIL FERTILITY

It is generally recognized that one of the important advantages enjoyed by the farmer who markets his crops through animals is the conservation of the fertility of his soil. Animals retain in their bodies only a small part of the plant food elements contained in the feeds consumed, returning the greater part to the soil in the manure produced. As a result the livestock farmer is able to maintain his land in a high state of fertility with the purchase of a smaller amount of fertilizers than is needed by the farmer who sells his grain.

Table 11

ANNUAL PRODUCTION OF MANURE BY DIFFERENT CLASSES OF FARM ANIMALS*

Class of Animals	Solid Excrement (1,000 tons)	Liquid Excrement (1,000 tons)	Combined Excrement (1,000 tons)	Percentage of Total Production
Horses and mules	85,787	19,504	105,291	12
Cattle	519,258	193,698	712,956	79
Sheep	15,890	9,856	25,746	3
Hogs	31,163	17,893	49,056	6
Chickens	4,768	—	4,768	0 5
Total	656,866	240,951	897,817	100 5

* Ohio Bulletin 605

It has been estimated that one billion tons of manure are produced annually by the livestock on the farms and ranches of the United States.[1] The greater part of it is produced by cattle, as shown by the data given in Table 11. The value of this manure in terms of the increased yield of crops which would result if it were completely recovered and carefully used is enormous. For example, a 3-ton appli-

[1] Ohio Bulletin 605, p 3.

position represented by these elements, but in general legumes contain a larger amount of nitrogen and phosphorus than do other forage plants and cereals. Animals require a certain amount of these elements for growth of new tissue, especially muscle and bone, and for the supply of salts in the blood and other body fluids. Old animals that have reached their maturity retain very little of these elements, whereas young animals use a considerable amount in the process of growth. Consequently the percentage of the nitrogen, phosphorus, and potassium consumed that is voided in the excrement depends upon the character of the feed and the age of the animals. Non-pregnant cows that are wintered on clover or alfalfa hay return well over 90 per cent of all three constituents, whereas young calves fed a poorly balanced ration of corn and timothy hay will probably return not more than 20 to 25 per cent of the first two elements, and not more than 50 per cent of the potassium in the feeds eaten. The approximate range and average percentage of the fertilizing elements contained in the feed that are excreted in the manure are shown in the following list:

	Average
Percentage of consumed nitrogen excreted, 50 to 90	75 per cent
Percentage of consumed phosphorus excreted, 70 to 90	85 per cent
Percentage of consumed potassium excreted, assumed	90 per cent
Percentage of consumed organic matter excreted, 20 to 50	30 per cent

Although these percentages are somewhat higher than those we should expect to get with yearlings or calves, they emphasize the great saving in soil fertility that cattle feeding makes possible.

Table 13

RECOVERY AND DISTRIBUTION OF FERTILIZING ELEMENTS CONTAINED IN THE FEED*

	Percentage Recovery					
	Nitrogen		Phosphoric Acid		Potash	
	In Feces	In Urine	In Feces	In Urine	In Feces	In Urine
Dairy cows: Ohio	40	28	63	1	17	61
Total excrement	68		64		78	
Steers, Ohio	61		87		82	
Steers, Pennsylvania	69		75		81	
Steers, England	96		93		99	
Heifers, England	78		78		86	
Average	75		80		85	

* Ohio Bulletin 605.

advantages of feeding cattle on legume pasture instead of in dry lot is the greater amounts of the plant food elements present in the feed which are returned to the soil where they will be available to the cultivated crops grown in the rotation. Breeding cattle, which must be kept near the farmstead during the winter months because of their need for shelter during inclement weather, should be turned onto pastures, meadows, and cornstalk fields whenever the ground is dry or frozen hard enough to prevent serious trampling of the soil, so that their droppings may be deposited where they will benefit future crops. *To require cattle to stand day after day in small dirt lots not only* deprives them of needed exercise but results in the loss of much valuable manure.

Losses of plant food elements in the manure of cattle that are kept in barns and sheds may be greatly reduced by using liberal amounts of bedding, by feeding the cattle in small paved lots, and by adopting proper methods of storing and handling the manure itself. Inasmuch as approximately half of the nitrogen and fully three-fourths of the

FIG. 15. Manure loses most of its fertility value when cattle are fed in large, unpaved, muddy lots. (Corn Belt Farm Dailies.)

Table 14

PLANT FOOD ELEMENTS EXCRETED BY TWO-YEAR-OLD STEERS EXPRESSED IN PER CENT OF AMOUNTS PRESENT IN CLOVER HAY FED*

Level of Ration Fed	Organic Matter Excreted (%)	Nitrogen Excreted (%)	Phosphorus Excreted (%)
Maintenance	91.5	334.8	650.5
One-third full feed	105.8	336.7	655.7
Two-thirds full feed	114.2	324.3	602.2
Full feed	121.2	308.6	589.3
Average	108.18	326.12	620.7

* Illinois Bulletin 209.

Maintenance of Fertility by Cattle Feeding. One sometimes hears the argument advanced that livestock farming is really less efficient than grain farming in maintaining the fertility of the land, since livestock raising involves the feeding of the legumes grown, while grain farming provides for their plowing under, thereby returning 100 per cent instead of only 75 to 90 per cent of the nitrogen and phosphorus in these important soil-building crops. This argument can be successfully refuted by replying that the man who plows under clover nearly always sells his grain, while the man who feeds his clover feeds his grain as well. The accompanying figures, obtained from an Illinois digestion experiment, emphasize the advantages possessed by the cattle feeder over the most progressive grain farmer in the matter of maintaining soil fertility (Table 14). The cattle in the experiment were fed corn and clover hay during the first 22 weeks and corn, linseed meal, and clover hay during the last 15 weeks. One part of linseed meal was fed to 4 parts of corn.

Saving the Manure. In the experiment just cited, all the elements of fertility excreted by the cattle were saved. It must be admitted that under ordinary prevailing conditions on the average farm a large percentage of the manure produced by the animals never reaches the fields where it is so badly needed. Instead it is trampled into the mud of the feedlot or is washed by the rains into a nearby stream. Under such conditions it is not to be expected that cattle feeding will do much towards maintaining the fertility of the soil. It is safe to say that under ordinary conditions fully one-half of the manure produced is lost. A large part of this loss may easily be prevented by keeping the cattle out on pasture and fields as much of the time as possible so that manure may be deposited where it will benefit future crops. One of the

potassium excreted are in the urine, it is extremely important that the liquid manure be saved by the use of suitable bedding materials. The ability of the different bedding materials to absorb and hold moisture is shown in Table 15.

Amount of Bedding. The amount of bedding material required by cattle depends upon the way the cattle are handled and the frequency with which the manure is removed. Purebred cattle are often housed in box stalls and the manure removed every day. Under such conditions the cattle are usually out of the barn for about 9 hours a day during the winter season and are on pasture almost all of the time during the summer months. Stock cattle and steers on feed, however, are generally kept in droves varying in size from 10 to 100 or more head. They are given an open shed and are free to go in and out as they please. Rarely are such cattle removed from the lot during the entire winter or finishing period. Although the manure accumulating in the shed may be removed every week or 10 days, the more common practice is to allow it to remain for a month or two or for the entire period, adding enough bedding from day to day to insure the cattle's having a dry bed.

Workers at the Illinois Experiment Station found that about 8 to 10 pounds of bedding material were required daily per mature animal when the cattle were kept in well-bedded, single stalls with concrete floors that were cleaned daily; only half this amount was required for 1,000-pound steers fed in open sheds that were cleaned only once a month. Approximately 10 per cent more wheat straw than oat straw was required to keep cattle equally well bedded, and it was necessary to use 80 per cent more shavings than oat straw to bed cows properly in single stalls.[2]

Corn cobs and shredded corn stalks are used by many cattle feeders in areas where corn is extensively grown. Cobs are the special favorite of cattle feeders who like to bed the feeding shed deeply at the beginning of the feeding period in the fall, with little or no cleaning out of the feed lot until the finished steers are sold in the late spring or fall. In this situation manure and cob bedding are often not hauled to the fields until just before plowing is started in the fall. By this system there is a minimum loss of mineral elements before plowing under, and only one handling of the manure is necessary.

Loss of Nitrogen and Organic Matter. Animal manures are extremely good media for the development of nitrifying bacteria. Unless the action of these organisms is checked, much of the organic matter of the manure is broken down and a large percentage of the

[2] Journal of Agricultural Research, Vol. 14, pp. 187–189.

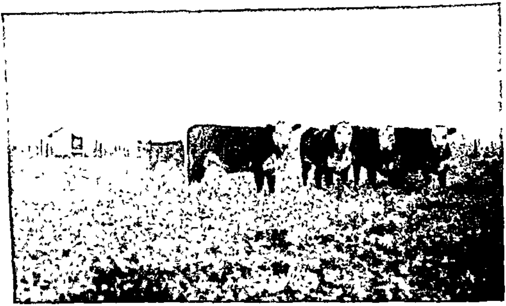

FIG. 16. When fattening rations are fed on rotation pastures, large proportions of the fertilizer elements in the feeds are deposited where they will be available for cultivated crops which follow pasture in the rotation (University of Illinois.)

Table 15

CHARACTERISTICS OF VARIOUS BEDDING MATERIALS*

Material	Bedding Required to Absorb 100 Pounds of Liquid (pounds)	Fixing Capacity for Ammonia-Nitrogen Held per Ton of Bedding (pounds)	Pounds of Fertilizing Elements per Ton of Air-Dry Material		
			N	P (P_2O_5)	K (K_2O)
Wheat straw	45	4.5	11	4	20
Oat straw	35	7.1	12	4	26
Rye straw	45	3.4	12	6	17
Corn stalks (shredded)	25–35	5 3	15	8	18
Chopped straw	20–30	—	—	—	—
Wood shavings, softwood	25	0.0	4	2	4
Wood shavings, hardwood	45	—	—	—	—
Spent tanbark	25	—	10–20	—	—
Leaf litter	25–60	26.6†	16	6	6
Peat moss	10	40.0	16	2	3
Sawdust	25	0 0	4	2	4

* Ohio Bulletin 605.

† *Oak leaf litter.*

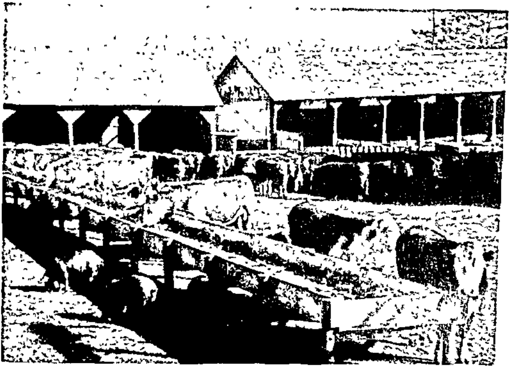

FIG. 17. Paved feeding floors and well-bedded sheds insure that most of the fertility in the feces and urine will be saved from this dry lot program, so that it may later be applied to the crop land. (Corn Belt Farm Dailies.)

overcome by the generous use of bedding. Beef cattle, however, spend a considerable amount of time outside their barns and sheds. If this time is spent in a dirt lot, often knee-deep with mud, all the manure dropped in the lot is a total loss and cannot be recovered.

At the Ohio Experiment Station two lots of steers were fed, one on earth floors and the other on concrete floors. They were kept in the barn at all times, except for two or three hours each day when they were turned out for water. No attempt was made to recover the manure deposited outside the barn. The amount of manure recovered from each lot and its composition are shown in Table 17.

Preservatives. Experiments have shown that the application of certain minerals, notably gypsum and raw rock or acid phosphate, to manure as it is formed decreases the losses due to bacterial action and leaching. Inasmuch as almost all tillable land is deficient in phosphorus, and also since manure is in need of more phosphorus to make it a "balanced" fertilizer, the mixing of rock or acid phosphate with the fresh manure is to be strongly recommended. If the manure is allowed to accumulate in the shed, one of these "reinforcing" materials may be scattered over the floor every two or three days at the

nitrogen is liberated into the air. Manure that is loosely piled in the open air decomposes very rapidly with great losses of organic matter and nitrogen. The following extracts from important treatises on farm manure are given to show how serious such losses may sometimes be:

1. Two tons of manure containing 1,938 pounds of organic matter and 48 pounds of nitrogen were left exposed during 4 summer months. At the end of this period the organic matter had been reduced to 655 pounds and the nitrogen to 27.7 pounds.[3]

2. Manure stored in heaps in the open from November to May lost 30.6 per cent of its dry matter, 33.5 per cent of the nitrogen, and 8.3 per cent of the phosphorus.[4]

3 Manure allowed to accumulate in the open barnyard for a period of 3 to 6 months is from one-half to one-third as valuable as that hauled directly from the stall to the field or properly stored in a manure shed (where it is worked over and trampled by the cattle and hogs).[5]

Fortunately these nitrifying bacteria are aerobic; that is, they require the presence of air for their development. Consequently, their action can be partially checked by so thoroughly packing the manure that the air is largely excluded. This result can be accomplished best by allowing the manure to accumulate in the shed where it will be trampled by the cattle.

Table 16

*Fertility Value of Trampled and Loosely Piled Manure**

Method of Storage	Percentage of Plant Food in Feed Recovered in Manure N	P	K
On concrete floor, trampled	85	81	91.5
On earth floor, piled under cover	54	69	71.0

* Pennsylvania Bulletin 63.

Concrete Floors and Paved Lots. Losses from leaching are largely, if not entirely, eliminated by the use of concrete floors and paved lots. Paved lots are really more important than the concrete floors inside the shed since the losses on dirt floors can be largely

[3] Cyril G Hopkins, *Soil Fertility and Permanent Agriculture*, Ginn and Co, 1910, p 200

[4] Indiana Circular 49, p. 8.

[5] Ohio Bulletin 216, p. 732.

were fed large quantities of coarse roughage and, hence, produced a great amount of feces. Trials at the Illinois Experiment Station, while by no means extensive, indicate that these figures are considerably out of line for beef cattle, especially where heavy grain rations are fed.

In these experiments the total length of time the steers were on feed was 37 weeks. This time was divided into 5 periods of approximately equal length. The ratio of grain to roughage was changed at the beginning of each period, the grain being gradually increased as the experiment progressed.

Under farm conditions the term "manure" refers to both the excrement and the bedding. The farmer is interested primarily in the amounts of such mixture that he will have available to apply to the land. At the Illinois Experiment Station it was found that purebred beef cows, kept overnight in single stalls that were cleaned daily, produced about 44 pounds of manure per day.[7] Approximately 36

Table 19

EFFECT OF CHARACTER OF RATION ON AMOUNT OF MANURE PRODUCED*

Ratio of Hay to Corn to Linseed Meal	Average Feces per Day			Average Urine per Day			Total Excrement per Day		
	Maintenance (lb.)	Full-Fed (lb.)	Average (lb.)	Maintenance (lb.)	Full-Fed (lb.)	Average (lb.)	Maintenance (lb.)	Full-Fed (lb.)	Average (lb.)
1:1:0	19.2	57.1	38.4	9.0	12.0	9.7	28.2	69.1	48.1
1:3:0	11.0	44.2	27.3	10.8	13.1	11.7	21.8	57.3	39.0
1:5:0	8.5	26.7	18.0	5.6	8.0	9.0	14.1	34.7	27.0
1:4:1	7.7	22.3	15.8	6.6	14.3	10.2	14.3	33.6	26.0

* Illinois Bulletin 209

pounds represented the actual excreta and the other 8 pounds the straw used as litter. Assuming that the cows were kept in the barn for 6 months, the total amount of manure saved per cow during the wintering period was about 4 tons. Approximately the same amount is obtained from yearling steers kept in open, well-bedded sheds during a 6- or 7-months' feeding period.

More manure, of course, is saved if the cattle are on pavement when they are outside their shelter. Tests conducted at the Ohio Experiment Station, already referred to, show that the use of concrete floors under the shed alone results in an increase of 15 per cent in the amount of manure saved. Inasmuch as cattle spend from one-third

[7] Journal of Agricultural Research, Vol. 14, pp. 187–189

Table 17

CONCRETE FLOORS AS A MEANS OF CONSERVING MANURE*

	Manure Recovered per Day per 100 pounds Live Weight (pounds)	Percentage of Plant Food in Feed Recovered N	P	K
Concrete floor in barn	47.5	75	78	88
Earth floor in barn	41.3	62	78	78
Difference in favor of concrete floor	6.2	13	00	10

* Ohio Bulletin 246.

rate of one pound per mature animal per day. If the manure is removed daily and stored, the reinforcement should be scattered over the pile. If hogs are allowed access to the pile, a thorough mixing of the materials will result.

Manure Produced. The amount of manure produced by a 1,000-pound steer or cow depends so much upon the character and amount of feed eaten that it is impossible to give an accurate figure for the daily or yearly production. Van Slyke[6] states that a mature cow produces, per 1,000 pounds live weight, 74 pounds of manure per day, or something over 13 tons per year. Of this amount, 52 pounds are represented by the feces and 22 pounds by the urine. These figures have been quoted widely by many writers and are found in most agricultural textbooks that mention the subject of farm manures. Apparently they are based on results obtained from dairy cows that

Table 18

*LOSSES FROM TREATED AND UNTREATED MANURE**

	Percentage Lost—January to April			
	Organic Matter	N	P	K
Untreated	35.47	35.63	22.46	51.02
40 lb. rock phosphate per ton	26.71	33.61	4.47	32.96
40 lb. acid phosphate per ton	38.13	31.56	17.00	38 02
40 lb. kainit per ton	36.47	30.51	16.67	43.85
40 lb. gypsum per ton	33.11	29.65	9.73	54.37

* Ohio Bulletin 246.

6 Lucius L. Van Slyke, *Fertilizers and Crops*, Orange Judd Co., New York, 1912.

part II

THE COMMERCIAL COW AND CALF PROGRAM

chapter **4**

ESTABLISHING THE COMMERCIAL HERD

Before starting a commercial beef cow herd one should be very certain that this is the beef program which best utilizes the feed production capabilities of the farm or ranch. The choice of the most suitable beef cattle program is a very important step. A number of considerations are involved in making this choice and among the important ones are:

1. Kind and amount of pasture to be utilized.
2. Relative amounts of grain and roughages produced on the farm or ranch.
3. Season during which labor is most unoccupied with other work.
4. Seasonal market demands for feeder and/or slaughter cattle in the area.
5. Proximity to market outlets and surplus feed supplies.
6. Climate.
7. Available equipment and shelter.
8. Financial situation of the operator.
9. Training, skill, and experience of the operator.
10. Personal likes and dislikes of the operator.

No one program is best suited to all conditions, and each has its advantages and disadvantages. The cow and calf program is growing in popularity as shown by the increasing numbers of new herds being established, especially east of the Mississippi River. Some would have us believe that this increase is largely due to the periodic high prices that must be paid for stockers and feeders obtainable from the range states. It is doubtful that this is the real reason. The cow and calf program has these several distinct advantages over other beef cattle programs:

1. Beef cows can produce more pounds of valuable product (calves) from poor to average pastures and low-grade roughages.

The cow and calf program has some real disadvantages, however, and these must also be considered in choosing a cattle program. These disadvantages are:

1. The cow and calf program is a long-time program. Returns come slowly and the program is not too well adapted to tenant farming. Concerning this point someone has said, "Many tenants cannot wait that long and most landlords won't."

2. The program is inflexible; that is, it cannot readily be changed in size or method of management to adapt to unforeseen difficulties or to take advantage of unexpected higher cattle prices. The cowman seldom is able to take advantage of drastic price rises because, even though his cows may increase in value, he cannot sell them and stay in business.

3. A better grade of labor and management is required than is needed for certain other types of programs.

FIG. 19. Income from a productive cow herd makes possible the clearing of land and application of seed and fertilizer which are required to establish improved pastures such as this one in Georgia. (American Hereford Association.)

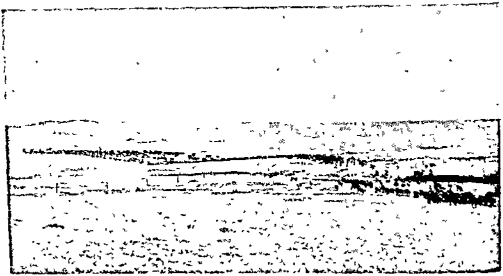

FIG. 18. The commercial cow and calf program maximizes returns from pastures or range such as the Sandhills area of northwestern Nebraska, as shown by research at agricultural experiment stations and 75 years of practical experience on the part of ranchers. (The Record Stockman.)

2. This program is less speculative; that is, there is less risk of losing large amounts of money owing to rapidly declining prices.

3. A beef cow herd is a very good stabilizer. The man with a successful cow herd is less likely to be an "inner and outer," trying to outguess the cattle market to his own downfall. There is probably reason to wonder whether stability, as used here, is cause or effect.

4. The man with a combination of pasture, roughage, and grain to market through cattle can raise healthy stocker or feeder cattle of a better grade than he would be apt to buy for his own feedlots.

5. The man with a cow herd can utilize labor and equipment that may already be on the farm and which would not otherwise be used. *For example*, a former dairy farm, well equipped with barns, silos, and fences, and operated by family labor, may best be utilized with a cow herd.

6. A cow herd can and usually does increase in value over the years by being graded up in quality through the use of good bulls and by growth in numbers.

7. This program is perhaps the most satisfying because it covers the whole gamut of experiences with cattle. No doubt this is the main reason why the beef breeding project is among the most popular of all projects for 4-H and FFA members. It has been aptly said, "The way to keep a boy on the farm or ranch is to give him a heifer of his own."

Table 21

A Comparison of Calving and Weaning Records of Commercial Cow Herds of the Major Breeds of Beef Cattle*

(10-year average)

	Angus	Hereford	Shorthorn	Totals and Averages of All Breeds
Number of herds	165	171	38	374
Number of cows	5,011	4,910	934	10,855
Number of calves	4,779	4,679	904	10,362
Calf crop, per cent	95.4	95.3	96.8	95.5
Average weaning age, days	208	207	202	207
Average weaning weight, pounds	448	446	426	445
Average daily gain	1.76	1.77	1 71	1.76

* *Charles R. Kyd, Missouri Extension Service. Information to the senior author*

the individuals of any one breed than between the best, or even the average representatives, of any two of them that it is almost useless to argue over their respective merits. One thing is certain: If a man has a distinct preference or liking for a particular breed, that breed in all probability is the one for him to use. It is not likely that he will ever be entirely satisfied with any other, for he will find it hard to be enthusiastic about a breed other than that of his choice. In the absence of such a preference, however, he should choose the breed that is most popular in the community in which he lives. The very fact that it is prominent is a good indication that it is well suited to the conditions of that locality. Moreover, such a choice will enable him to avail himself of the services of the outstanding bulls of the community and to use the selling agencies that have been perfected by the older breeders. But perhaps the most important advantages that come from such a choice are the opportunity to observe the methods employed by other breeders, to compare their cattle with his own, and to make purchases from herds about which he has definite knowledge.

Breeders of each breed, whether producing purebreds or commercial cattle, should strive to improve the breed of their choice in the characteristics in which weaknesses are most apparent. In each breed, breeding stock can be found which is acceptable or even very strong in those points where the breed needs improvement.

Crossbreeding. The crossing of breeds is much less widely praticed with beef cattle in America than with either swine or sheep.

4. Losses due to disease, calving difficulties, and sterility are high compared with other cattle programs.

5. The volume of business or gross income is small for the large investment in cattle and land; thus the minimum-sized herd for profitability represents a comparatively large dollar investment.

6. Average to good pastures, good roughages, and concentrates can be converted to more pounds of gain with some of the other cattle programs.

The Choice of the Foundation Breeding Stock. The choosing of the animals that are to be the foundation stock for the breeding herd is a matter of prime importance. Far too often insufficient attention is given to their selection. Particularly is the young breeder, in his eagerness to start operations, likely to take too little time to consider properly just what animals will best suit his needs. He grows impatient at what seems to him to be a loss of time, and to get started he purchases the animals that are immediately available, even though he knows full well that they fall far short of the kind he really wants. Such a procedure is to be avoided, for usually a herd that is established hastily in this way is found to be so unsatisfactory that it is soon replaced either by cattle of much higher merit or by some project which is entirely different from a beef breeding herd.

Once a herd is established it is usually the best idea to raise one's own replacement heifers. This is because of the disease control problem present when outside animals are added, rather than from the standpoint of making progress in improvement in performance and type. Decisions have to be made almost every time a calf crop is weaned in order to choose the best heifers to keep, but since only a few cows are replaced each year, these decisions are not nearly so important as those involved in laying the foundation.

Choosing the Breed. In some ways it is unfortunate that we have several breeds of beef cattle of the same general type, because many men waste considerable time and effort in attempting to decide which breed is best for their particular conditions.

The choice of breed is, for practical purposes, unimportant to all but those cowmen operating in the Gulf Coast region. It is a well-established fact that the Brahman, the Santa Gertrudis, and the so-called newer breeds which trace their foundation to an infusion of Brahman breeding, are better suited to this region, at least so far as performance is concerned. Otherwise all of the principal British breeds are well adapted to the climate and feed conditions of the remainder of the country. So much more variation exists between

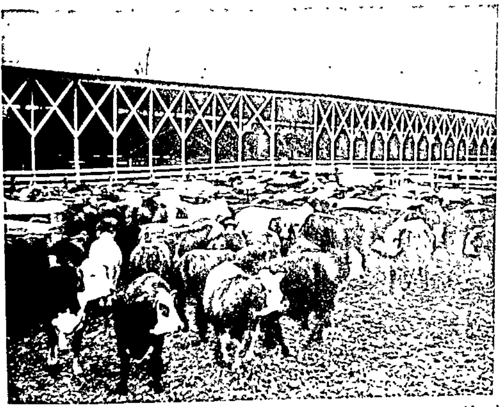

FIG. 20. Brahman X British breed or native cow crossbreds are considered "excellent doing" cattle when free of parasites. When fed to high-good or low-choice finish, as are these steers in an Illinois feed lot, they yield highly acceptable carcasses.

two parent stocks. A more logical explanation of the differences noted is to be found in the normal differences in size and weight of the two breeds and in the difference in milking ability of Angus and Hereford cows. Until more definite information is available on the advantages of crossbreeding the British breeds of beef cattle, it would seem that it should be employed principally for the purpose of quickly obtaining valuable characteristics that have already been achieved in another breed and not in the expectation that the crossbred calves will possess any characteristic in higher degree than it is found in one or the other of the breeds used.

An increasing number of ranchers are mating first-calf Hereford heifers to Angus bulls in the belief that this practice will reduce calving difficulty. This seems logical because the resulting calves will be smaller at birth. A small-type Hereford bull is also often used for this reason. The experimental data on this point are not sufficiently conclusive to recommend the practice without reservation, however.

Indeed it has been done so infrequently and on such a limited scale that insufficient data are available to permit a sound appraisal of its value.

One of the most carefully conducted crossbreeding tests with beef cattle reported to date was performed at the Ohio Station with Angus and Hereford cattle. The results of this test, which extended over 8 years and involved both purebred Angus and Hereford offspring as well as reciprocal crossbred calves, are summarized in Table 22. Since both kinds of purebred and both kinds of crossbred calves were produced each year in the Ohio experiment and the same bulls sired purebred and crossbred offspring, comparisons are more valid than can be made in most crossbreeding tests. The results indicate little significant effect of hybrid vigor. Hybrid vigor, or heterosis, is a term used to describe the superiority of offspring over the average of the

Table 22

A Comparison of Purebred and Crossbred Calves*
Eight-Year Summary

	Purebred Hereford	Hereford Bull × Angus Cows	Angus Bull × Hereford Cows	Purebred Angus
Male calves, number weaned, 8 years	46	50	46	49
Average birth weight lb	69	66	67	62
Average weaning age, days	219	227	224	235
Average weaning weight lb	394	473	432	486
Average gain on full feed	338	352	346	331
Average days on full feed	197	203	197	202
Average daily gain.				
a. Birth to weaning, lb	1.48	1.79	1.63	1.80
b. *On full feed*	1.72	1.73	1.75	1.64
Corn eaten per cwt. gain	526	586	594	641
Female calves, number *weaned, 8 years*	*51*	*42*	*48*	*42*
Average birth weight lb.	68	63	63	56
Average weaning age, days	219	226	218	229
Average weaning weight, lb	386	447	394	420
Average gain on full feed	306	302	310	295
Average days on full feed	190	185	192	186
Average daily gain:				
a. Birth to weaning, lb.	1.45	1.70	1.52	1.59
b. On full feed	1.61	1.63	1.62	1.59
Corn and cob meal eaten per cwt. gain	562	597	606	620

* *Ohio Research Bulletin 703, 1951.*

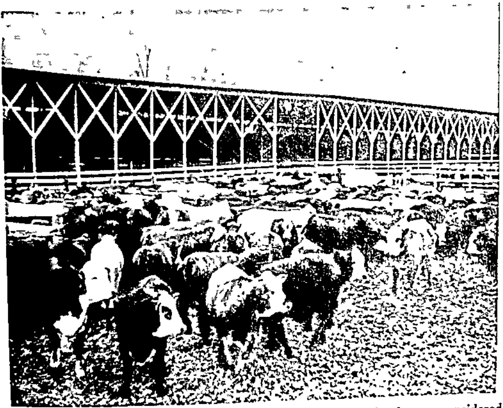

FIG. 20. Brahman X British breed or native cow crossbreds are considered "excellent doing" cattle when free of parasites. When fed to high-good or low-choice finish, as are these steers in an Illinois feed lot, they yield highly acceptable carcasses.

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Average days on full feed	197	203	197	202
Average daily gain				
a Birth to weaning, lb	1 48	1 79	1.63	1.80
b On full feed	1 72	1 73	1.75	1.64
Corn eaten per cwt gain	526	586	594	641
Female calves, number weaned, 8 years	51	42	48	42
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Average weaning weight, lb	386	447	394	420
Average gain on full feed	306	302	310	295
Average days on full feed	190	185	192	186
Average daily gain:				
a Birth to weaning, lb	1 45	1 70	1 52	1.59
b. On full feed	1 61	1 63	1.62	1.59
Corn and cob meal eaten per cwt gain	562	597	606	620

*Ohio Research Bulletin 703, 1951.

additions to the herd. Replacements which are produced in one's own herd should be free of these diseases if the herd is healthy. However, annual tests should be made on these additions as well. Compliance with federal and state regulations concerning these diseases is fast becoming mandatory in all areas of the country. It is hoped that the progress made in ridding the country of these diseases will continue until all herds are disease-free.

Calfhood vaccination is giving good protection against brucellosis, but this cannot be said for the other diseases mentioned. Breeding animals should be bought subject to negative tests for these other diseases. Tests made more than 30 days before delivery of the animals to the buyer should not be accepted. All herd additions should be isolated from the rest of the herd for 60 to 90 days and a re-test should be made before they are released from quarantine.

Many other diseases affect breeding cattle—for example, tuberculosis, anthrax, and anaplasmosis—but these are comparatively uncommon. Nevertheless, attention should be paid to them and some consideration should be given to the area of origin of the cattle. More will be said about these and other diseases in Chapter 29.

INDIVIDUALITY. As used here, individuality includes all those characteristics in an animal which may be noted from a visual inspection. Size, body type, quality, bone and set of legs, breed and sex character, and temperament all come under this heading. The use made of visual appraisal of the individuality for acceptance or rejection of breeding animals varies from using such an appraisal as the sole means of selection to completely ignoring the appearance of the animals. Some of the visible characteristics of breeding cattle are due to a combination of inheritance and environment. This fact complicates selection. All too often the first calves produced by the foundation stock or herd replacements bear little resemblance to their sire or dam and do not measure up to expectations. This is usually due to environmental factors such as degree of fatness and previous treatment of introduced cattle, which led the prospective breeder astray. Some of the characteristics mentioned, however, are highly heritable—that is, they can be expected to be passed on to offspring with considerable regularity. Performance records are much more reliable for selection for such characteristics as rate of gain, efficiency of feed utilization, and carcass qualities, than are visual appraisals.

Characteristics such as breed character or breed type contribute to the sales appeal of commercial cattle. These characteristics must be appraised visually, since they cannot be accurately measured with scales or calipers. Unfortunately, as experienced breeders know, these

When Brahman bulls have been crossed on either native cows or cows of the British breeds under controlled experimental conditions, the resulting calves have always outweighed the straight-bred controls at weaning time, and the advantage has usually been 25 to 50 pounds. This result is as would be expected because the Brahman breed is a large breed It should also be mentioned that the more tropical or semi-tropical the area in which the test was conducted, the greater the advantage in favor of the crossbreds. Even more advantage may be expected in weaning weights if the cows are Brahman × British or native crossbreds rather than straight-breds. The advantage demonstrated by the Brahman crossbred is generally less in the feed lot after weaning, and decline in slaughter grade may more than offset the advantage of faster and more efficient gain if more than one-fourth Brahman blood is present. It is doubtful if crossing Brahman bulls on cows of British breeding is of value in the more temperate regions of the country. This statement could also be made if the objective is to produce feeder cattle which are to be fed to better than good grade. Slaughter tests show that as "fat calves" or as medium to good grade slaughter yearlings, the Brahman crosses yield very acceptable carcasses with comparatively high cut-out values.

Choice of Animals for the Commercial Herd. The following items should be given much consideration in choosing the animals which are to form the foundation of a new herd or which are to serve as additions or replacements for a herd already in existence:

1. Freedom from disease.
2. Individuality.
3. Performance records (if available).
4. Performance of near relatives.
5. Age.
6. Cost.

Freedom from Disease. The most important item in the determination of profits is percentage of calf crop, and the best insurance against poor calving percentage is a healthy herd. High selling prices due to extra quality and weight or low feed costs cannot offset low calving percentage and large death losses.

Important contagious reproductive diseases of breeding cattle which must and can be guarded against are brucellosis (contagious abortion), leptospirosis, and vibriosis in females and trichomoniasis in bulls. These diseases can be minimized at the time of purchase by demanding negative results from tests conducted by qualified veterinarians on all breeding animals composing the foundation stock or

individual records are not kept on each cow or calf in the herd. The implication is not that western ranch-bred females are not desirable foundation material. Quite the contrary, more good surplus females are found there than elsewhere because, for the most part, much attention has been paid to economically important characteristics over a period of many years. In addition, since the numbers of cows are relatively stable in this region, not nearly all of the heifer calves or yearlings are needed for herd replacements.

More and more ranchers and operators of farm herds are performance testing. Weaning weight and weaning type-score are the two principal kinds of information recorded for heifer calves. Though such breeders usually practice performance testing in order to choose their own herd replacements, the surplus females which have good weights and weaning scores should make suitable foundation material for many prospective purchasers. If yearling heifer weight and type score can be obtained in addition to the information obtained at weaning time, so much the better. However, there are few available grade yearling heifers about which this information is known, except those sold in dispersal sales.

The breeding ability of the sire or dam of prospective foundation females is another good guide to follow in making selections. Since a sizable number of a sire's calves or progeny usually can be seen on one ranch or farm, one should inspect as many of them as possible in order to evaluate the sire. An unselected sample of progeny should be seen—those from poor cows as well as those from the good cows. Calves which are creep-fed or otherwise pampered are not of much help in evaluating a bull's breeding worth.

The breeders of some areas have established reputations as good producers of foundation females A new breeder would do well to ask for expert help, even when buying his females from such reputation areas, because not all herds in such areas are outstanding. In addition, prices are usually higher. It is equally true that such an area is a good place to buy females because more herds can be seen in less time and more good cattle are offered for sale. The feedlot performance of large numbers of steers or heifers from a herd over a period of years is a very good practical guide to follow in seeking foundation females.

As for the bull or bulls to be used in a new commercial herd or as a replacement, here nothing less than an excellent purebred bull on which performance data are available should be suitable Such data, to be complete, should include weaning weight corrected for the age of the calf and for the age of the dam, weaning type-score, feed conversion

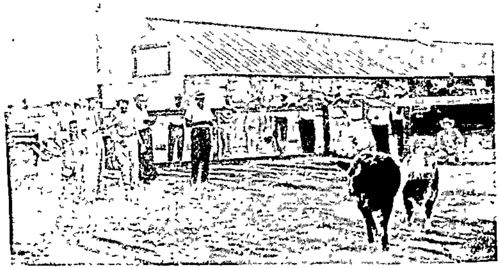

FIG. 21. Evaluation of the conformation or type of a calf at weaning time by several judges is an important part of most performance testing programs. (C. H. Codding and Sons, Foraker, Oklahoma.)

characteristics are no more reliably passed on to offspring than others previously mentioned. In addition, research work indicates that these characteristics are not as closely associated with productivity as once believed. Observation of many near relatives is a good, though not perfect, guide when selecting young breeding cattle insofar as the "hard to measure" characteristics are concerned.

Breeders and feeders alike often express a preference for a certain shade of red in their Hereford feeders or breeding cattle. Premium prices are paid to the extent of 50 cents or 1 dollar per hundredweight for yellow-colored Hereford feeders in many instances, and shade of red may mean as much as several hundred dollars' difference in the selling price or cost of a bull. South Dakota workers[1] recently published data which show clearly that shade of red in Herefords is not correlated with performance and that neither a premium nor a discount should be expected when selling or buying Herefords which are either extremely light or dark colored.

Performance Records (if available). So far as grade females which are to serve as a foundation for a commercial herd are concerned, records concerning their performance or productive ability are seldom available. This statement is especially true if these females are bought in the range areas where herds are generally large and

[1] South Dakota Farm and Home Research, Vol. IX, 1957, pp 27–30.

Table 23

RELATIONSHIP OF PRODUCTION TO TYPE AND WEIGHT OF BEEF CATTLE

	Type and Size	
	Compact	Large
Cow weight, lb.	934*	1,066*
Calf weight, lb.	417	469
Calf weight produced per 1,000 lb. weight of cow	448	440
Percentage of cows which weaned calves	81.6	93.8
Average calf weight produced per cow in the herd	340	440
Average calf weight per 1,000 lb. cow in the herd	366	413

* Weights taken when calves were weaned.

ing their lifetimes the larger cows produced 40 per cent more calves and 50 per cent more total calf weight. Thus large size at maturity in foundation cows and heavy weights in foundation heifers seem to be essential characteristics to look for in starting a herd. Should an earlier-fattening type of offspring be desired, special consideration can be given to this trait when selecting the sire.

AGE. Age groups of females available for foundation female material can be grouped according to numbers available, in descending

Table 24

LIFETIME PRODUCTION OF COWS OF DIFFERENT TYPE AND SIZE

	Type and Size	
	Compact	Large
Number of cows	78	69
Average age when removed from the herd, years	7.1	8.1
Total calving periods	397	415
Number of calves born	324	399
Calving percentage	81.7	96.1
Calves died of natural causes	25	20
Calves died of accidental causes	1	6
Number of calves weaned	298	373
Percentage of cows which weaned calves	75.1	100.0
Average number of calves born per cow	4.2	5.8
Average number of calves weaned per cow	3.8	5.4

data for at least a 120-day feeding period, and a 12- or 15-month weight and type score.

Records alone, of course, mean nothing. Obviously bulls with poor records should not be offered for sale but some breeders, in their eagerness to make use of a "performance-tested" bull make the mistake of thinking that a bull with records, even though only average, should be better than a bull with no records.

Special attention should also be paid to breed type in the bull—for example, a Hereford bull should conform to the standards set for bulls of this breed. He certainly should show plenty of evidence of masculinity, growthiness or "weight for age" in the absence of performance data, and exceptional soundness on his feet and legs with adequate high-quality bone. He should be smooth in his covering, even in his lines, and show much evidence of muscularity as well as an inclination to fatten on good rations. Highly fitted bulls should usually be avoided because their breeding ability is often impaired. Next year's calf crop may be delayed because of time lost while the fitted bull is restored to proper breeding condition. Perhaps the most important reminder of all is that only very expert judges can consistently evaluate the highly fitted bull.

Performance of Near Relatives. Performance records of near ancestors of prospective foundation stock should be used, when available, in making selections of breeding cattle, but information obtained from such records should be combined with desired individuality. Fortunately in all breeds there are animals of excellent beef conformation and breed type which also possess the much-desired superior performance. It is true that such animals are not plentiful, but much progress is being made in making matings in many purebred herds which result in a large percentage of excellent breeding cattle.

The New Mexico Experiment Station[2] has conducted an experiment which gives some interesting and rather conclusive answers as to what the effect of type and size is upon productivity of the beef cow. First the New Mexico workers chose the 40 most compact and the 40 largest cows from their 200-head Hereford cow herd. The cows were bred each year to bulls of their same type, and lifetime production records were kept. Tables 23 and 24 give the pertinent data and it must be concluded that the larger cows were more productive. True, when the weaned calf weight is calculated per 1,000 pounds weight of cow which calved, there is no difference, but the larger cows lived longer, and more of them calved and weaned calves each year. Dur-

[2] J. H. Knox, Report, New Mexico A. and M. College Cattle Breeders' School, 1956.

the herd. The drove can be culled to size after the calves have been fed and handled in their new surroundings for 2 or 3 months, and the rejected females can be fed out for slaughter. Heifer calves offered for sale are usually of better quality than yearling heifers, especially if the above procedure is followed. Too often the yearling heifer droves may include late-dropped calves from the year before or they may include heifers which had been intended as replacements in the original owner's herd but are now for sale because subsequent development proved disappointing. The effect of age upon the future productive life of females is discussed in Chapter 6

Age is also an important consideration in selecting bulls Obviously a 4- or 5-year-old bull that has sired 2 or 3 crops of good-doing calves of the right type is a much safer bull to buy than a younger, unproven bull or a bull calf that has yet to demonstrate his breeding ability However, not too many such bulls are offered for sale and often they are in great demand if of excellent quality. If the herd is already in production, a good plan is to buy a yearling bull to use on a few females while the older bull is still in use. Thus he can be progeny tested—that is, offspring sired by him can be compared with calves sired by the main herd bull. Young bulls should be used sparingly, as is discussed in Chapter 9. Great skill is required in selecting weanling bull calves as future herd sires, unless one has performance data on the calves themselves, as well as progeny data on the sire and dam of the calf, or unless one can see many close relatives in more mature stages of development.

COST. Naturally cost is an important consideration in selecting commercial breeding cattle, but it should not crowd out all others. Far too often price becomes the all-important factor in deciding which animals to purchase. As a matter of fact, price should be the last consideration within reasonable limits. If closely culled grade females are bought, a 20 to 25 per cent premium over feeder cattle market price is not unreasonable. If young heifers are bought, the added weight at disposal time, as old cows, will often offset the premium paid at purchase time. If a drove of females is bought in which no culling was permitted by the seller, naturally one would reasonably expect to pay a somewhat lower premium, amounting to perhaps only 10 per cent above market price, or no premium at all. Locally grown cattle of equal quality have an advantage with respect to price due to considerably lower transportation and incidental costs. There is also less likelihood of losses due to shipping fever and similar diseases

Good bulls can usually be bought for the equivalent value of 3 to 5 choice-grade finished steers Producers of superior performance-tested

order, as follows: (*a*) weanling heifer calves, (*b*) yearling heifers (usually bred), and (*c*) older cows with or without calves at side. From a quality standpoint the older cows, having withstood annual cullings, may be best. However, they may be for sale because of advanced age and reasons related to age, such as bad disposition, poor udder, and slow breeding tendency. Cows which are culled for such reasons are not apt to be profitable additions to a herd. If mature cows are for sale owing to a forced reduction in cow numbers on a ranch or farm because of drought, settling of an estate, or the like, then such females are often very desirable foundation stock.

Western ranchers like to offer their heifer calves and yearling heifers for sale in droves without undue culling or sorting. Therefore, if such females are bought to start a commercial herd, considerably more, even twice as many, should be bought than are needed to start

FIG. 22. Many ranchers wait until after the wintering period to decide which heifers to keep for replacements, in order to get more information concerning their growth rate and type. High condition in calves at weaning time, due to heavy-milking mothers, can mislead a breeder in selecting replacements. (American Angus Association.)

Methods of Establishing a Commercial Herd. Since the average farmer or rancher seldom establishes more than one cow herd in a lifetime, it is certainly important to him to make his foundation choices carefully and wisely. Seeking advice from an experienced neighbor, a reputable, professionally trained dealer or commission man, or a county agent or vocational agriculture teacher is especially advisable if the buyer is inexperienced. Some time-tested methods of starting a herd are:

1. Buy a complete herd with a good reputation when a farm or ranch is changing hands. This method requires considerable capital, but returns come quickly and ordinarily the quality is high, unless some topping out has occurred. By all means the lower end of such a herd should not be purchased alone, even though it may seem to be a bargain.

2. Buy twice as many heifer calves as will ultimately make up the cow herd from a herd with a good reputation. The better half of the drove may be selected for foundation females on the basis of performance as shown by weight, or size (if scales are not available), beef type or conformation, disposition, and uniformity after being fed on a good growing ration for 2 or 3 months or until early spring. The remaining half of the heifers may be disposed of through any one of several heifer feeding plans which are discussed in Chapter 13. Returns come more slowly from such foundation females but the initial investment is comparatively low and considerable culling may be practiced.

3. Buy yearling heifers in the fall, again buying extras to permit culling before making final choices, after the cattle have spent several months on the purchaser's farm. Inasmuch as yearling heifers from the range area will quite likely already be bred unless guaranteed open, a pregnancy test should be made to reveal those not bred. The open heifers, together with the culls, can then be fed out for the spring market. This method has the advantage over the purchase of heifer calves, because the first calf crop is obtained one year earlier. However, initial costs are higher and the opportunity for culling is reduced.

4. Buy cow and calf pairs, preferably from areas in which numbers are being reduced for reasons other than simple culling—for example, from areas in which extended drought is forcing a drastic reduction in cow numbers. Such cows will ordinarily be bred at the time they are offered for sale in late summer or early fall. The steer calves and undesirable heifer calves can be sold or handled in any one of the many programs discussed in Chapter 12. Naturally such cows will not be the best cows on the farm or ranch from which they came but the

bulls do and should expect somewhat higher prices because considerable labor and expense are involved in conducting such tests. Furthermore, not nearly all of the bulls so tested will prove to be superior.

Sources of Foundation Females. Sources of good female breeding stock for the foundation of a commercial beef herd vary with the section of the country. Obviously anyone wishing to start a herd in the range area has a relatively simple job so far as this point is concerned because ranchers in the neighborhood will quite likely be able to supply his wants. On the other hand, good females are harder to come by in areas where few herds are located or where most of the herds are small or are themselves expanding in numbers. Of course, even in the latter areas range-area females may be secured through dealers or commission men or by direct purchase. Extra costs such as transportation and commission and the fact that little sorting can be done means that this source may be more expensive. In the non-range areas, then, more thought and time must be given to procurement of females.

Some sources of females and methods of procurement are:

1. The occasional complete or intact herd available because of circumstances beyond the control of the owner or operator.
2. The normally surplus heifer calves and yearling heifers in the range areas.
3. Cow and calf pairs in the range areas, especially in periods of extended drought when forced herd reductions are necessary.
4. Dispersal sales which are often held to settle estates, divide partnerships, and so forth.
5. Regularly scheduled auction sales, especially those held in states which have close supervision of health requirements.
6. Private treaty purchase from neighbors.

Sources of Breeding Bulls. Purebred herd bulls for use in commercial herds may be obtained from several sources, and the source is not so important as *the bull himself*. Satisfactory sources of breeding bulls, in descending order of choice, are:

1. A proven but sound bull, purchased from another breeder.
2. A young performance-tested bull, purchased privately from a breeder or in a sale of performance-tested bulls.
3. A bull from a reputable purebred breeder, after inspecting the sire, dam, and other near relatives.
4. Purebred bull sales where a screening committee has rigidly culled the sale offering.

chapter **5**

HERITABLE PRODUCTIVE TRAITS IN BEEF CATTLE

Anyone who has carefully observed a beef cow herd or a drove of feeder steers has noticed that all cows or steers do not perform or produce alike. Some steers are termed "good doers" and others, "hard feeders" even though sired by the same bull and produced in the same herd. Some cows produce heavy calves of good type without serious loss of condition, whereas others give scarcely enough milk to nurse their late-dropped, off-type calves. The large amount of variation observed in such cases arises because the heredity of different cows and calves varies and because all individuals do not live under exactly the same environmental conditions. The new individual created by union of sperm and ovum has a unique and permanent complement or combination of hereditary factors or genes. The new, single-celled individual grows in size and complexity by cell-division and differentiation of tissues into special organs and structures. Each new body cell contains the same genes present in the original zygote (fertilized egg), and these genes condition the biological processes performed by cells and the increasingly complex individual. The precise effect of a particular gene complement depends upon external forces of the environment such as temperature, availability of nutrients, competition for space, and so forth. Identical twins have exactly the same heredity, yet at birth may differ in many minor respects. Such variations are caused by exposure to slightly different environments or to accidents which may favor one twin more than the other. Less closely related pairs of calves are less apt to resemble one another, because they not only are exposed to different environments but because each is likely to possess some genes not present in the body cells of the other

Beef cattle traits or characteristics are descriptions which reflect differences between animals due to both environmental and hereditary causes. Only those differences or that part of the differences caused by variations in heredity can be transmitted to the offspring. Part of the environmentally caused differences may be reproduced among

calves at side will tend toward the average of the herd from which they came and will be evidence of the quality of the herd. If such cattle are from a drought area, the buyer should take into consideration the lack of flesh or condition in the case of the cows and the lack of weight and bloom in the calves due to the poor rations of the cows.

5. Grading-up the native beef females, or even dairy cows of the heavy breeds such as Holstein and Brown Swiss, available in the area. This method takes several years but the results are often very good. The use of at least three successive beef bulls of excellent quality and bred-in performance will result in good beef-type cows, especially if a performance-testing program is begun from the start and only the best heifers are retained. The disease problem is greatly reduced by this method if the usual recommended procedures for disease control are followed. The initial outlay of capital is again comparatively low, consequently this method is well suited to young men just starting in the business. The selection of the herd bull is of the utmost importance in this method.

chapter **5**

HERITABLE PRODUCTIVE TRAITS IN BEEF CATTLE

Anyone who has carefully observed a beef cow herd or a drove of feeder steers has noticed that all cows or steers do not perform or produce alike. Some steers are termed "good doers" and others, "hard feeders" even though sired by the same bull and produced in the same herd. Some cows produce heavy calves of good type without serious loss of condition, whereas others give scarcely enough milk to nurse their late-dropped, off-type calves. The large amount of variation observed in such cases arises because the heredity of different cows and calves varies and because all individuals do not live under exactly the same environmental conditions. The new individual created by union of sperm and ovum has a unique and permanent complement or combination of hereditary factors or genes. The new, single-celled individual grows in size and complexity by cell-division and differentiation of tissues into special organs and structures. Each new body cell contains the same genes present in the original zygote (fertilized egg), and these genes condition the biological processes performed by cells and the increasingly complex individual. The precise effect of a particular gene complement depends upon external forces of the environment such as temperature, availability of nutrients, competition for space, and so forth. Identical twins have exactly the same heredity, yet at birth may differ in many minor respects. Such variations are caused by exposure to slightly different environments or to accidents which may favor one twin more than the other. Less closely related pairs of calves are less apt to resemble one another, because they not only are exposed to different environments but because each is likely to possess some genes not present in the body cells of the other

Beef cattle traits or characteristics are descriptions which reflect differences between animals due to both environmental and hereditary causes Only those differences or that part of the differences caused by variations in heredity can be transmitted to the offspring. Part of the environmentally caused differences may be reproduced among

offspring if the environmental factors responsible can be properly controlled. It is convenient to consider each trait as influenced by both genetic and non-genetic factors, and to describe traits according to the percentage of differences among parents which are transmitted to their offspring. This percentage is termed the *heritability* of the trait in question The greater the importance of heredity in causing differences between animals, the higher the heritability of the trait under consideration Thus some characteristics are said to be more heritable than others Resemblances between parent and offspring or among progenies of individual bulls are greater for highly heritable traits than for traits of lower heritability.

Two systems of testing prospective breeding animals for their ability to perform with respect to economically important traits are generally termed *performance testing* and *progeny testing*. Performance testing applies to the measurement of an animal's ability to grow, convert feed to gain, produce and wean a calf, or to yield a high-quality carcass. This measured performance, to be of most value, must be compared with the performance of other animals of the same age being fed similar rations under similar conditions.

Progeny testing refers to the comparison of the breeding values of sires (or dams) based on the performance or appearance of calves which they produce. Progeny test information is intended to serve as a basis for further selection among tested sires. Most so-called progeny testing is of little use for this purpose, however, since the opportunity for selection among tested sires is very insignificant. Progeny test information does improve the evaluation of potential sires because it increases the reliability of pedigree information. Extensive use of true progeny testing may actually decrease the rate of genetic improvement, because it increases the interval between generations and thereby decreases the annual rate of improvement. It is most useful for traits that can be measured early in life, traits which are limited to one sex (for example, milk production), and traits which require sacrifice of immature animals (such as carcass value). If heritability is low, the amount of attention paid to progeny tests should be increased, but individual performance should receive a greater proportion of attention if heritability is intermediate or high.

Performance and progeny testing have long been common practices with other species such as dairy cows, race horses, and laying hens, perhaps because the production of these species is comparatively easy to measure Milk scales, stop watches, and trap nests are effective tools for evaluating an individual's performance and that of its progeny. With respect to beef cattle, some far-sighted, practical beef cowmen

have culled cows, selected replacement heifers, and added new sires to their herds for many years on the basis of a combination of their performance and conformation. Applying the old adage of "like begets like," they made some progress, although it was slow. The better the herds became, the more difficult it became to make further improvement. Many of the purebred breeders supplying the sires used in commercial herds placed most of the emphasis in selection upon type or conformation. Progress was made in this direction, but at the expense of possibly more important traits, economically speaking.

Fortunately the traits of high economic importance are generally highly heritable—for example, the superior growth rate shown by a particular bull or female above the average of a comparable age group can be expected to be passed on to its offspring to a rather high degree. Testing large numbers of prospective herd sires and female replacements for the traits of high economic importance identifies those animals most likely to be inherently superior. Because, as mentioned previously, these traits are likely to be transmitted to a high degree, performance testing of young individuals offers real hope for improvement.

Heritability. Not all traits are inherited to the same degree. Some are influenced more by environment than by heredity. Animal breeding specialists employ a term called *heritability* to describe the degree to which a trait may be expected to be transmitted from parent to offspring. Heritability of 50 per cent means that about half of the superiority found in the parents is found in the offspring. These figures represent averages computed from large numbers, so cannot be expected to predict the outcome perfectly for every individual case.

Ranking animals on the basis of their performance, especially with respect to those traits which have high heritability, tends also to rank them in order of breeding value for those traits. Table 25 gives heritabilities published by three different research workers. The fact that small discrepancies may appear reflects the sampling nature of the heritabilities but it is encouraging that, for the most part, agreement is close.

Attention to many traits at a time reduces the rate of improvement for the various individual traits. A practical approach seems to be one of at first emphasizing the highly heritable traits with high economic importance, such as yearling weight, final feedlot weight, and area of loin-eye, until these traits are much improved in the herd. At the same time a minimum standard for traits of lower heritability, such as weaning grade, weaning weight, and feed conversion, could be set, below which no bulls or herd replacements would be permitted to fall.

discussed in more or less the order in which they are chronologically expressed by the animal.

Reproductive Capacity. Regularity of breeding is highly desirable, and a calving interval of more than 12 months greatly increases overhead and cannot long be tolerated in a beef cow. Experimental data which can be used to establish the role of inheritance for this trait are few and inconclusive. Geneticists are generally of the opinion that heritability is quite low for this trait and that such factors as disease, level of nutrition, adaptability, and management are responsible for most of the difference, especially that found between herds. The occasional cow in a herd that, even under poor feed conditions, consistently calves early, or the all too numerous cows that continually calve later and later each year or fail to calve at all, are evidence that hereditary characteristics of the cow are involved. Records of cow and bull reproductive performances may be of some use as a basis for culling and to the extent that hereditary differences are involved may accomplish genetic improvement.

Longevity. The period of productive life is far too short for most beef cattle. Not only is mere reproduction for a long period important, but the weight of calf weaned during the later years of the life of a cow is also highly important. Declining milk production with advancing age, due either to inability to rustle for the necessary feed or to inherently poor milk production, results in light-weight calves. Tables 26 and 27 show the effect of age in range cows upon cow weight, calf weaning weight, and reproductive efficiency. Herds of long-lived, productive cows have a lesser proportion of young, immature females and thus more of the total feed and pasture requirements of the herd is being used by productive-aged cattle. A study of Table 28 reveals that 57.2 per cent of the cows in a large experimental range herd had been disposed of at the average age of 7 years and that only 9 per cent

Table 26

EFFECT OF AGE UPON THE WEIGHT OF BEEF COWS AND UPON THE WEANING WEIGHT OF THEIR CALVES*

Age of Cows (years)	Average Weight of Cows (pounds)	Average Weight of Calves (pounds)	Age of Cows (years)	Average Weight of Cows (pounds)	Average Weight of Calves (pounds)
3	908	387	7	1021	434
4	952	405	8	1017	430
5	983	429	9	993	436
6	1013	447	10	981	422

* New Mexico Press Bull. 1004

Table 27

EFFECT OF AGE OF RANGE BEEF COWS UPON THEIR PRODUCTIVITY*

Age at Calving Time (years)	Number of Cows	Production			
		Cows		Calves	
		Percentage Dry	Percentage Pregnant	Percentage Born Alive	Percentage Born Dead[a]
3	412	15.0	85.0	95.4	4.6
4	397	19.4	80.6	96.2	3.8
5	341	14.1	85.9	96.9	3.1
6	288	15.6	84.4	96.7	3.3
7	219	18.7	81.3	97.2	2.8
8	176	14.8	85.2	98.0	2.0
9	128	13.3	86.7	98.2	1.8
10	76	15.8	84.2	92.2	7.8
11	37	18.9	81.1	100.0	0.0

* Baker and Quesenberry, U.S D.A., Journal of Animal Sci., 3, p. 81, 1944.
[a] Abortions, stillbirths, and losses due to inclement weather.

of the cows remained in the herd beyond 10 years of age. Causes other than age alone were involved here, but undoubtedly age played a big role. When, as in many herds, 7- or 8-year-old cows are considered old and are few in numbers, one can estimate that from one-fourth to one-half of all heifer calves dropped must be kept and developed for normal herd replacements. This figure is too high for profitable production and a goal of having to save not over 15 per cent of the heifers each year can be and is being achieved in herds where much attention is paid to longevity. Heritability for this trait has not yet been established.

Birth Weight. It is well known that birth weights of calves dropped by different cows vary considerably and that birth weight has a high repeatability—that is, successive calves from a cow tend to have similar birth weights, especially if sired by the same bull. However, using birth weight, which of course is easy to obtain, as the only criterion for selecting replacements or for culling, is not necessarily an effective way to improve other important performance traits (even yearling weight). It is known that length of gestation, age of dam, sex of calf, and breed of calf influence birth weight. Contrary to a

rather commonly held opinion, age of the sire does not affect the birth weight of a calf.

Mothering Ability. Weaning weight and the condition or bloom of a calf are indications of the mothering ability of a brood cow. Thus it is a very easy trait to measure. Weaning weights of calves from first-calf heifers are a very good indicator of the future productivity of young cows. The information on the weaning weights of calves is of much value in culling unprofitable cows, as shown by the data in Table 29. The table shows a close relationship between the weaning weight of the first calf of a cow and the average weight of those she produces during the following four years.

Both inherent growth rate of the calf and the milking ability of the cow are involved in evaluating this trait. Because the level of milk production by the brood cow is greatly influenced by level of nutrition, age, season of calving, and still other environmental factors, the heritabilities of weaning weight and weaning grade are rather low as compared with those of some of the other economically important traits.

Table 28

ATTRITION SUFFERED BY 412 BEEF COWS DURING THEIR STAY IN THE BREEDING HERD[a]

(Data from U.S.D.A. Range Experiment Station, Miles City, Montana)

Age at Calving (years)	Total Cows	Cause of Disposal								Total Disposals		
		Dry 2 Years		Abortion or Reactors		Died During Year		Other Sales[c]		Number	Percentage[b]	Cumulative Percentage[b]
		Number	Percentage[b]	Number	Percentage[b]	Number	Percentage[b]	Number	Percentage[b]			
3	412	...	.	1	0.2	9	2.2	5	1.2	15	3.6	3.6
4	397	31	7.5	16	3.9	3	0.7	6	1.5	56	13.6	17.2
5	341	6	1.5	8	1.9	17	4.1	22	5.3	53	12.9	30.1
6	288	8	1.9	17	4.1	6	1.5	38	9.2	60	16.7	46.8
7	219	5	1.2	10	2.4	6	1.5	22	5.3	43	10.4	57.2
8	176	4	1.0	2	0.5	3	0.7	39	9.5	48	11.7	68.9
9	128	2	0.5	6	1.5	1	0.8	43	10.4	52	12.6	81.5
10	76	1	0.2	3	0.7	1	0.2	34	8.3	39	9.5	91.0
11	37	0	0.0	0	0.0	1	0.2	36	8.7	37	9.0	100.0
Total	412	57	13.8	63	15.3	47	11.4	245	59.5	412	100.0	

[a] Baker and Quesenberry, U.S.D.A., Journal of Animal Science, 1944, Vol. 3, p. 82.

[c] Including sales for undesirable type, unsatisfactory calves, old age, cancer eye, etc.

[b] Percentage of the original number of cows.

gains are no longer being influenced by the level of milk produced by the mother, have shown that great differences exist in gaining ability on pasture or in the feed lot. Heritability ranges from 50 per cent upwards. When these heritabilities are based on final weights or on weights which correspond to selling weights after finishing, they reach the very high level of about 85 per cent. Data such as those shown in Table 30 indicate the extent of the variation that may be due to sire differences, and of course the sire contributes only half of the genetic make-up or background of a calf. Perhaps of most significance is the final column in this table, in which the bulls are rated on the ability of their sons to return dollars above feed costs in the feed lot. These differences in return above feed cost are principally a result of differences in both rate of gain and efficiency of feed conversion or ability to convert feed into gains. Still another difference noted, though less variable, is that of slaughter grade, in which case the faster gaining steers outgraded the slower gaining steers.

Because the heritability of growth rate is so high, the individual performance of prospective herd sires and replacement heifers on pastures or in feed lots is an excellent guide in making selections. For example, two top-gaining bulls from the Balmorhea, Texas, Central Bull-Testing Station, purchased for use in the Blue Bonnet experimental herd, sired calves which, over a 5-year period, gained an

Table 30

AVERAGE RESULTS OF RECORD-OF-PERFORMANCE FEEDING OF EIGHT STEERS FROM EACH OF 13 BULLS*

Bull No.	Birth Weight (lb.)	Weaning Weight (lb.)	Final Weight (lb.)	Daily Gain (lb.)	Slaughter Grade	Returns Above Feed Costs ($)
T7	81	493	1,079	2.32	G+	148
T9	92	464	1,054	2.34	G+	137
T8	82	460	1,040	2.32	G	136
T4	79	399	965	2.25	G	126
T10	81	422	981	2.22	G+	126
T11	84	418	998	2.30	G	126
T3	81	433	1,004	2.27	G+	123
T5	82	397	966	2.26	G+	121
T2	82	394	940	2.17	G+	116
T12	80	438	959	2.07	G	116
T1	83	401	934	2.12	G−	113
T6	73	374	893	2.06	G	112
T13	83	392	868	1.89	G−	103

* U.S.D.A. Information Bulletin 18.

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Table 29

VALUE OF WEANING WEIGHT OF FIRST CALF FOR PREDICTING AVERAGE WEIGHT OF CALVES SUBSEQUENTLY PRODUCED BY SAME COW*

Cow Groups	Average Weaning Weight of First Calf from 3-Year-Old Cows	Average Weaning Weight of Calves from Same Cows for Next 4 Years
1	321	404
2	349	417
3	383	430
4	409	443
5	441	456

* New Mexico Experiment Station, *Journal of Animal Science*, 6: 461–466.

In the fat-calf program (see Chapter 24), milking ability, as reflected in calves carrying a high degree of baby or milk fat and bloom, is of utmost importance because condition or finish plays such a large role in determining selling price for this type of calf.

Daughters of high-producing cows are most likely to make superior mothers. In an Oklahoma study, 54 cows were divided into two groups, one a high-producing group of 27 cows whose lifetime average production was 510 pounds of calf weaned per year per cow, and the other a group of 27 cows which weaned an average of 471 pounds of calf per year. All calf weights were adjusted for age and sex—that is, weights were converted to a standard 210-day age and heifer weights were converted to steer weights. Daughters of these two groups of cows, all sired by the same bull and dropped in the same season, were bred to the same bull to drop their first calves as 2-year-olds. Daughters from the better producing group of cows weaned 392-pound calves, whereas the calves dropped by the daughters of the lower-producing cows weighed only 379 pounds, indicating that the productivity of the mothers was a good tool to use in selecting replacement heifers.

Weaning weight and grade of a calf are also influenced by the sire. Well controlled tests, where several sires were mated to a uniform group of cows, based upon past performance, showed that differences in adjusted weaning weights and in grades may be as much as 40 pounds and one-third of a grade, respectively. Progeny testing of sires in this manner may keep a breeder from using a poor sire more than one year.

Gaining Ability. Many experiments conducted with growing and fattening beef cattle, which extended beyond the age of weaning when

gains are no longer being influenced by the level of milk produced by the mother, have shown that great differences exist in gaining ability on pasture or in the feed lot. Heritability ranges from 50 per cent upwards. When these heritabilities are based on final weights or on weights which correspond to selling weights after finishing, they reach the very high level of about 85 per cent. Data such as those shown in Table 30 indicate the extent of the variation that may be due to sire differences, and of course the sire contributes only half of the genetic make-up or background of a calf. Perhaps of most significance is the final column in this table, in which the bulls are rated on the ability of their sons to return dollars above feed costs in the feed lot. These differences in return above feed cost are principally a result of differences in both rate of gain and efficiency of feed conversion or ability to convert feed into gains. Still another difference noted, though less variable, is that of slaughter grade, in which case the faster gaining steers outgraded the slower gaining steers.

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Table 30

Average Results of Record-of-Performance Feeding of Eight Steers from Each of 13 Bulls*

Bull No	Birth Weight (lb.)	Weaning Weight (lb)	Final Weight (lb.)	Daily Gain (lb.)	Slaughter Grade	Returns Above Feed Costs ($)
T7	81	493	1,079	2 32	G+	148
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average of 62 more pounds per calf during a 154-day feeding period after weaning, than the progeny of 39 untested sires. Although it was said earlier that level of milk production can affect weaning weight, heavy calves at weaning time tend usually to be fast gainers on pastures or in feed lots. This fact should allay the fears of feeders who sometimes express the opinion that heavy-weight, fleshy calves or yearlings are to be avoided when purchasing feeder cattle. It is true that excessive bloom or milk fat may be lost after weaning if these calves are placed on rather poor quality wintering rations, but this is simply a case of not suiting the calf to the feed supply.

Efficiency of Feed Conversion. Efficiency of feed conversion and rate of gain fortunately go hand in hand. Almost always improvement in rate of gain resulting from selection is accompanied by a decrease in amount of feed required per pound of gain. Texas Experiment Station studies at Spur and at Big Springs demonstrated that the low-gaining 30 per cent of their steers required 1,137 pounds of total feed per 100 pounds gain, as compared with 982 pounds for the medium 40 per cent and 957 pounds for the top-gaining 30 per cent. There is some evidence that efficiency of feed conversion is independently inherited, but because this trait is generally so closely associated with rate of gain, improvement in the latter trait almost certainly results in more efficient feed converters as well. Incidentally, it should also be mentioned that cattle which are bred to perform well on roughages or pastures likewise perform well on finishing rations. The fact that growthy, thin cattle gain better accordingly on heavy silage or hay rations than later when, as fleshy feeders, they are fed a finishing ration has led some feeders to speak of such cattle as good "roughage-type" cattle as contrasted with good "feedlot" cattle. It is doubtful if such differentiation is justified.

Type or Conformation. Type or conformation is important in the live beef animal because of its association with carcass grade, and hence selling price. True, carcass grade in slaughter cattle depends upon a combination of conformation, finish, and quality, and serious deficiencies in any one of these three points can downgrade a carcass. However, the buyer of feeder cattle, who may be looking at prospective feeders when they are thin, and even the buyer of slaughter cattle, lets conformation be the starting point in placing a value upon cattle.

Owing to past experience with large, off-type cattle, some experienced feeders and breeders are concerned with what they think may happen to the "type" of cattle as a result of placing so much emphasis upon rate of gain, as is done in many performance testing programs. The amount of emphasis to place upon a particular trait is for each breeder

to decide but, as mentioned earlier, more progress can be made in those traits which have high heritabilities. As seen in Table 25, type or conformation as reflected by weaning grade, yearling grade off grass, slaughter grade, and carcass grade all have lower heritability than those traits associated with growth. Thus, since progress, or for that matter, change in either direction, comes more slowly for these traits, it is unlikely that type will soon be sacrificed as a result of an improvement in rate of gain.

Fortunately most cattle which gain rapidly also grade quite well. A study of the relationship between the feedlot performance and appraised value or type score of 74 bull calves fed at the Fort Reno Station in Oklahoma revealed that competent judges, who knew nothing about the breeding and performance of the bull calves, placed high scores on fast-gaining bulls. It was found that two-thirds of the bulls which were among the top one-half on rate of gain were also among the top one-half for appraised value or score, as determined by visual inspection. This association between gain and type is not perfect, so scales should not be substituted completely for the eye or on-foot appraisal.

Conversely, placing type foremost in a selection program is bound to lead to disappointment so far as overall improvement is concerned, because the reverse of the situation just discussed is not true. That is, animals which grade high cannot always be expected to gain well. Another way of stating this point is that there is little correlation between type and performance, because the genes responsible for desirable type may not be those responsible for performance. In fact, there may be no genes which affect both type and performance. Age, condition, health, season of the year, and differences of opinion on the part of judges or graders as to what constitutes ideal type, all contribute to a high degree of inconsistency in grade or scores placed on the same animal. Investigators at the Arkansas station found that actual permanent differences between animals up to 10 years of age accounted for about half of the variation in scores for the same animals when scored semi-annually by a committee Young cows nursing their first calves scored considerably lower than the same animals did either as heifer calves, bred yearlings, or later as mature cows

Carcass Merit or Grade. Area of loin-eye is an objective measure of lean meat or the muscle content of a carcass. The loin and rib are the two highest priced cuts of meat in a beef carcass, and beef cattle breeders are indeed fortunate that the heritability for rib-eye area is one of the highest for all traits Great progress stands to be made when more performance test stations include steers for slaughter tests so that

the bulls can be found which sire calves that yield especially meaty carcasses with large loins and rib-eyes and heavy hind quarters. Even greater progress might result if some characteristic or feature of conformation could be found in the live animal which would accurately reflect carcass value, since more potential breeding animals could be evaluated.

Tenderness of the lean portion of a carcass enhances its value. This trait in beef carcasses is especially important because of its consumer appeal, and it undoubtedly has much to do with whether beef retains its rank as the meat of choice with most housewives. Limited experimental data indicate that this trait is heritable and that its heritability can be classed as intermediate—that is, neither high nor low.

Miscellaneous Traits. Still other economically important heritable traits in beef cattle that have value are disposition or temperament, soundness of feet and legs, shape of udder and size of teats, cancer-eye susceptibility, and such carcass traits as marbling and color of the lean and fat. These traits are difficult to measure, but when obvious weaknesses creep into a herd with respect to these traits, selection against them should be practiced.

Operation of the Performance Test. Performance records mean most to a breeder when collected under conditions which are similar to those in effect on his own farm or ranch. For example, a rancher in the Gulf Coastal region might find that cattle that performed exceptionally well in the high mountain country of the northwest failed badly because of poor adaptability when exposed to the temperatures and humidity of his home territory. Again, a breeder who may be in the business of rearing fat slaughter calves might be badly disappointed in the calves sired by a bull which did well in a performance test in the feed lot as a yearling on full feed. Undoubtedly, milk production should receive more attention in his case than performance as yearlings, since his calves will be sold for slaughter at weaning time or soon afterwards. It becomes obvious that there is no one best performance test for all the varied climatic conditions and differences in feed supply and market goals found in this vast country.

Performance testing work today can generally be subdivided into three categories: (1) On-the-farm or -ranch testing with or without outside assistance, (2) official testing in test stations supervised and controlled by breeder organizations, and (3) official testing in stations operated by agricultural colleges and experiment stations.

Cooperative Government Beef Cattle Breeding Research Program. Guidance in performance testing programs has come from state agricultural experiment stations and the United States Depart-

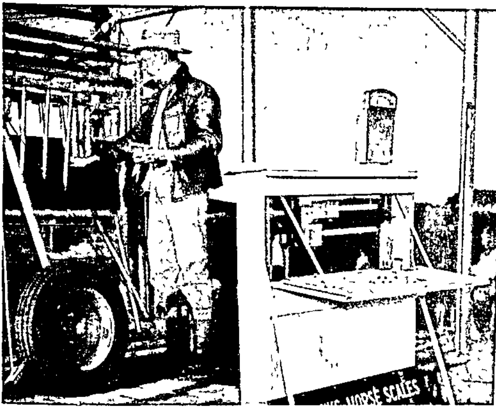


FIG. 23. Individual identification of all calves and accurate weights are essential in carrying on a performance testing program. (C. H. Codding and Sons, Foraker, Oklahoma.)

ment of Agriculture, and this guidance is an outgrowth of state-federal cooperative breeding projects initiated in 1946. To date, 36 states (including Hawaii) have joined with the U. S. D. A. in a vast coordinated beef breeding project that represents all of the types of climate, feed supply, and programs of beef production. For convenience, the work is organized into three regional projects designated as the Western, North Central, and Southern regional projects.

Supervision of Performance Testing. Agricultural extension workers and vocational agriculture teachers are doing much to establish performance testing work on farms and ranches and are often given the responsibility of supervising official testing stations. Necessary record forms and supplies and even portable scales are supplied by extension workers in many states. Scales are also often provided by feed companies and, in other instances, local or state performance registry associations provide scales.

Because the type of cattle program, type of feed, and other factors vary so much, each state or locality usually has to develop its own

best performance test, and aid can usually be secured from the local county agent, farm adviser, or vocational agriculture teacher.

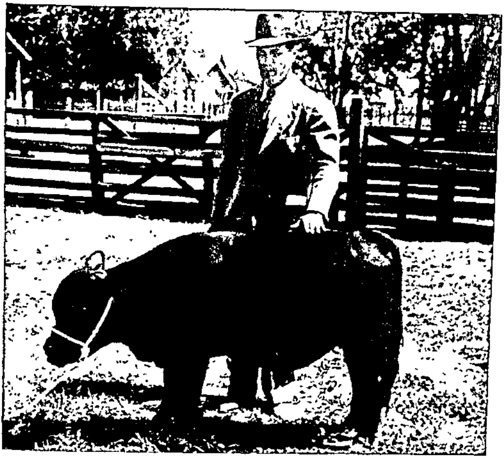
The *Performance Registry International* is a non-profit organization which was organized in 1955 to encourage the keeping of performance records of beef cattle and to foster the use of these records as an aid in selecting and propagating more productive breeding cattle. The objectives of the organization are listed in its constitution as follows:

1. To record officially the performance and the production of tested animals registered with the various beef breed associations;
2. To encourage accurate measurement of the performance and production of beef cattle;
3. To promote the improvement of beef cattle in the economical production of high quality meat;
4. To cooperate with the various breed associations in the promotion of better cattle;
5. To encourage the use of breeding stock with proven high gaining ability in both registered and commercial herds and help establish markets for the produce from such herds;
6. To publish such literature as is deemed necessary to accomplish these objectives;
7. To acquire and hold such real and personal property as may be required to carry out the associations' corporate undertakings.

This organization sponsors a recognition program for superior cattle by listing such cattle in a Performance Registry. Thus the organization is hopeful of increasing the appreciation of, and consequently the value of, superior breeding stock. The organization is growing and now has members in 23 states and 2 foreign countries.

Dwarfism. The "snorter" dwarf or freak has reached a frequency in two of the major beef breeds so that its occurrence causes substantial financial losses and attention must be paid to it or it may reach proportions which breeders can ill afford. *This inherited trait is characterized* in the newborn calf by extreme shortness of leg and compactness of body, bulging forehead, protruding tongue, undershot jaw, labored breathing (snorting), incoordination, and high mortality. Arizona workers[1] recorded birth weights of large numbers of dwarfs and found that weight alone is a poor guide in distinguishing dwarf calves at birth. Weights above 60 pounds were common, with a maximum weight of 76 pounds being recorded. The length of the forecannon was the only measurable characteristic which rather consistently differentiated dwarfs from normal calves at birth.

[1] Arizona Experiment Station Bulletin 268



(a)

(b)

FIG. 24. Dwarf calves which show the sharply dished face and paunchy belly characteristic of the "bulldog" dwarf. (*a*) Angus dwarf, 11 months of age. (P. W. Gregory, California Experiment Station.) (*b*) Hereford dwarf and normal calf, both 10 months of age. (Illinois Experiment Station.)

Growth in the dwarf calf may be normal for a few months, but those calves that do not die soon after birth seldom live beyond a year of age. Death usually results from respiratory complications. Dwarf females that live to sexual maturity are usually fertile and live calves have been produced by dwarf females in experimental herds by Caesarian birth.

Dwarfism is believed to be inherited as a simple recessive character; consequently, its occurrence follows the well-known pattern described by Mendel's law.[2] In other words, the birth of a dwarf calf is proof that the factor for dwarfism is present in the germ plasm of both the sire and the dam, as illustrated in Fig. 25. A bull or cow which carries the dwarf gene transmits it to only half of his or her calves, none of which will be dwarfs, if the other parent does not also carry this gene. However, as is diagrammatically shown in Fig. 25, the offspring which do inherit the gene from one parent in turn transmit it to half of their calves, and thus the character continues to be in the herd, in latent form, generation after generation. Dwarf calves appear in disturbing numbers when a bull carrying the gene is used in a herd in which a high percentage of the cows also carry it. The probability of any particular calf inheriting a dwarf gene from each parent is ¼; the probability of it inheriting a dwarf gene from only one parent is ½; and the probability of receiving two normal genes when both parents are carriers is ¼ Thus in a herd of 100 carrier cows mated to carrier bulls, the result of a single calf crop may be expected to yield 25 per cent dwarfs, 50 per cent carriers, and 25 per cent normal non-carriers, but chance can cause the observed result to vary. These facts make the elimination of dwarfism from a herd in which it has become established a long and expensive procedure.

Tests for Dwarf Carriers. Recognition of carrier or heterozygous animals would simplify the problem of ridding a herd of dwarfism. Several tests have been proposed which showed promise, only to fail in actual use. Investigators are presently working on refinements of the "X-ray test" used on the spines of calves at birth, and the "insulin test" which shows considerable promise. Prospective herd sires may be tested with the reasonably sure "progeny test." This test consists of mating the bull in question with a number of cows proved to be carriers by having produced a dwarf calf from the service of a carrier bull. If the prospective sire is mated to 16 such cows and no dwarf calves are produced, the chances are only one out of a hundred that the bull is a carrier. Using fewer cows of course decreases the value

[2] J. L. Lush and L. N. Hazel, "The Inheritance of Dwarfism," *American Hereford Journal*, March 1, 1952, pp 32-34.

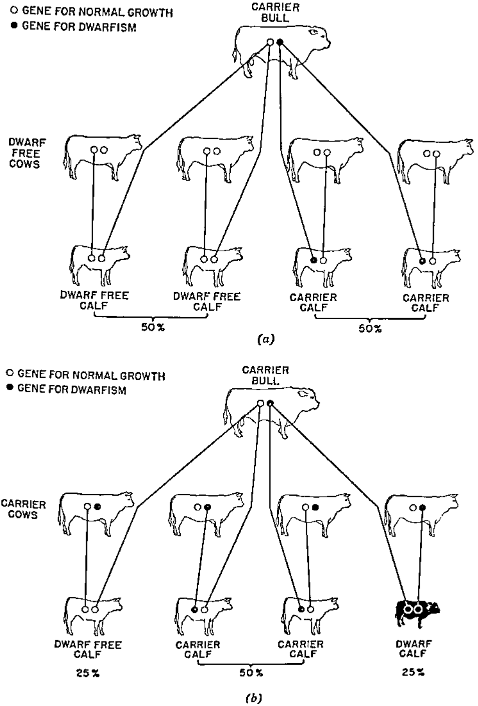


FIG. 25. (*a*) How the dwarf gene can be introduced into a dwarf-free herd. Fifty per cent of calves may be carriers, none will be dwarfs; (*b*) mating a carrier bull with carrier cows, 25 per cent of calves may be dwarf-free, 50 per cent carriers, 25 per cent dwarfs (Arizona Bulletin 268.)

Table 31

METHODS OF TESTING A BULL FOR THE PRESENCE OF A RECESSIVE DWARF GENE*

Number Matings ("N")	Number of Chances out of 100 that Bull Carries Recessive Dwarf Gene When "N" Matings, of Type Indicated Below, Produce Normal Calves Only		
	Test Bull × Carrier Cows	Test Bull × Cows from Carrier Sire *and* Dam	Test Bull × Cows from Carrier Sire *or* Dam
2	56.3	69.5	76.6
4	31.6	48.2	58.6
6	17.8	33.5	44.9
8	10.0	23.3	34.4
10	5.6	16.2	26.3
12	3.2	11.2	20.1
14	1.8	7.8	15.4
16	1.0	5.4	11.8
18		3.8	9.0
20		2.6	6.9
22		1.8	5.3
24		1.3	4.1
26		0.9	3.1
28			2.4
30			1.8
32			1.4
34			1.1
35			0.9
36			0.8

* J. F. Kidwell, *J. Heredity*, 42:215.

of the test as shown in Table 31. The table also shows that larger numbers of cows are required in the progeny test if the test cows are out of carrier cows and by carrier sires but have not themselves dropped a dwarf.

In a commercial herd it is doubtful if selling all the daughters of a carrier bull is warranted, economically speaking, because so long as only non-carrier bulls are used, no dwarfs will be dropped by the cows. True, the dwarf gene will be carried along in the herd and surplus heifer calves being sold might be bought by someone else to start a herd which would then contain carrier cows. The facts are that if everyone sold all the females suspected of being carriers, there simply

would not be enough guaranteed non-carrier females available to start the new herds. Those available would be extremely high-priced owing to the strong demand and short supply, and there would still be many unsuspected carrier cows used for breeding purposes.

Certain families or strains within the breeds are freer of the dwarf gene than others, especially within individual herds. There is some merit in buying bulls or replacements of such breeding, but certain limitations should be mentioned: (1) The price is sometimes very high and nearly always higher than can be justified for commercial breeding cattle; (2) such cattle may be inferior in performance and type, although they are not necessarily so; (3) cattle bought by family name may in fact have other breeding than that indicated by the family name.

It appears that the incidence of dwarfism is almost certain to continue to build up to a stabilized level of approximately 4 to 5 per cent, especially if carriers are preferentially chosen as replacements, unless a simple test for distinguishing the carrier animal is found soon. Dr J. L. Lush has estimated that the incidence of dwarfism would stabilize, under usual culling practices on a farm or ranch, as follows, under the conditions indicated:

100%	carrier	bulls	—	14.5% dwarfs
80%	"	"	—	10.0% "
50%	"	"	—	4.4% "
40%	"	"	—	3.0% "
20%	"	"	—	less than 1% dwarfs

This gene could be nearly eliminated from herds rather rapidly if a test were developed which would positively identify the carrier animals There are reasons to be optimistic that this discovery is not too distant in the future. In the meantime, although dwarfism is of considerable importance to some and of interest to all breeders, this problem is not going to ruin the industry as some would have us believe. Placing more emphasis upon selection based on performance and upon proper feeding and management stands a better chance of increasing the efficiency of beef cattle enterprises than applying all one's thoughts and energy to solving the dwarf problem.

chapter **6**

REPRODUCTION AND MATING

The per cent of calf crop weaned is the most important single factor in determining profit or loss in the cow and calf program. The term "per cent of calf crop weaned," as used in this text, refers to the number of calves weaned from all the cows and heifers of breeding age in the herd at breeding time.

It is reliably reported that the per cent calf crop weaned is as low as 60 per cent in most of the herds in certain areas, and not over 90 per cent in the best of herds throughout the country over a period of years. Table 32 illustrates the effect of per cent calf crop weaned upon the cost of each calf weaned under varying annual cow costs. Thus it becomes obvious that an *understanding of the physiology of reproduction of beef cattle is extremely important.*

Table 32

EFFECT OF PER CENT OF CALF CROP WEANED ON COST OF EACH CALF WEANED

	Annual Cow Cost		
	$ 100	$ 80	$ 60
Per Cent Calf Crop Weaned	Cost per Calf Weaned $	$	$
100	100	80	60
90	111	89	67
80	125	100	75
70	143	114	86
60	167	133	100

The Reproductive Organs of the Cow. The reproductive system of the cow consists of the genital tract and certain related organs. The genital tract may be described as a tube extending from the

FIG. 26. The first goal of every cattle breeder should be the production of a healthy, vigorous calf, normally born and well started by a mother cow of sufficiently good inherent milk production to raise a calf for every cow in the herd. (American Hereford Association.)

posterior end of the body, forward into the body cavity. This tube varies considerably in size and shape throughout its length and, inasmuch as each part performs a special function in the process of reproduction, each part is spoken of as an *organ* of the reproductive system. In accordance with such a definition the following reproductive organs exist in the cow:

1. *The Vulva.* The vulva is the exterior opening of the female genital tract. It consists of two *labiae*, or lips, which close the opening of the tract, and of an internal chamber just within the labiae, called the *vulvar cavity*. Into this cavity opens the *urethra*, the duct from the bladder.

2. *The Vagina.* That portion of the tract just forward of the vulvar cavity is called the vagina. It is about 10 inches in length and lies

immediately below the colon. Its principal function is to afford a passage from the uterus to the outside of the body.

3. *The Cervix.* This is a constriction in the genital canal that marks the division between the vagina and the uterus. It is also called the *os uteri*, or neck, of the uterus, and is really a cone-shaped part of that organ which projects back into the anterior end of the vagina. During estrus or "heat" and at the time of parturition or calving, the cervix is much dilated, but normally it is contracted so as to close the uterus. When it is closed so tightly as to make the passage of the male sperm cells into the non-pregnant uterus impossible, sterility, of course, results. During pregnancy the cervix is tightly closed and is sealed against the entrance of bacteria by a plug of mucus secreted by the mucous membrane of this region.

4. *The Uterus.* The uterus is that portion of the genital tract which is designed to retain and nourish the embryo or fetus between the time of fertilization and parturition. The uterus consists of a main portion or *body*, lying just beyond the cervix, and two branches, or *horns*, into which the uterus branches at its forward end. In the cow, the body of the uterus is relatively small, whereas the horns are long and large. For a short way they extend forward nearly parallel to each other, then curve downwards, outward, and backwards and then upwards, terminating near the lower wall of the vagina. The horns of the uterus are held in place by a tough, elastic membrane called the *broad ligament*, which forms a connection between the uterus and the abdominal walls.

5. *The Oviducts.* At the terminal of each horn of the uterus is a thread-like tubule called the oviduct, which leads to the ovary. There are two horns, just as there are two ovaries and two oviducts. Although the ovaries are but a short distance from the termination of the uterus, the oviducts are so tortuous that the total length of each is some 5 or 6 inches. At its outer extremity the oviduct broadens out to form a funnel-shaped opening called the *infundibulum*, into which the ripened egg migrates when liberated from the ovary. The walls of the oviduct are covered with cilia or threadlike projections, which facilitate the passage of the egg down into the uterus.

6. *The Ovaries.* The ovaries are groups of specialized cells, actually outside the genital tract, which produce, at fairly regular periods, the *eggs*, or *ova*, as the female sex cells are called. In the cow the ovaries lie loosely in the body cavity alongside the forward part of the vagina. They are oval in shape, about 1 inch in diameter around the thickest part. They may be felt with comparative ease by inserting the hand into the rectum. During advanced pregnancy the ovaries

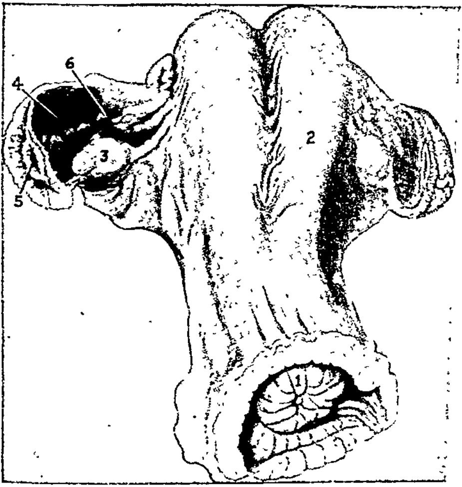


FIG. 27. The reproductive system of the cow. 1, cervix or os uteri; 2, right horn of the uterus; 3, ovary; 4, broad ligament; 5, the infundibulum of the oviduct; 6, the oviduct. (After Williams in "The Diseases of the Genital Organs of Animals.")

are displaced by the enlargement and forward and downward extension of the uterus. Each ovary consists of a cluster of small egg sacs, probably several thousand in number, and each sac is called a *Graafian follicle*. Every female is born with a number of Graafian follicles and still others develop throughout the lifetime of the cow. Each follicle contains an egg which eventually is theoretically capable of being fertilized and growing into a calf. The follicles remain in an unchanged state until the advent of puberty when, one at a time, they begin to enlarge through an increase in the amount of follicular liquid within, until eventually the wall is ruptured and the ovum liberated. Theoretically, the reproductive ability of a female persists

until all the ova have perished through ovulation or because of disease or old age. As a matter of fact, probably less than a hundred ova are liberated through ovulation during the normal life of a cow. The thousands not liberated are injured, or even destroyed, by diseases that affect the genital organs or, escaping this fate, the ova tend to become atrophied and degenerate with the advent of old age. In either case, of course, the animal is rendered barren.

From physiological studies it is known that reproduction is a very complex process which is carefully controlled by substances called *hormones*. Briefly stated, the role of hormones in reproduction is as follows: The process is initiated by the tiny *pituitary gland*, situated at the base of the brain, which secretes a hormone called *gonadotropin* which, upon being taken up by the blood stream, stimulates the growth of a Graafian follicle in one of the ovaries. Now this enlarging Graafian follicle itself produces a hormone called *estrogen* which, upon entering the blood stream, stimulates the secretion of mucus in the vagina and acts upon the central nervous system to cause the cow to show signs of "heat." Upon the rupture of the Graafian follicle the production of estrogen is stopped and a substance known as *corpus luteum* is formed in the crater of the follicle. The corpus luteum secretes a third hormone called *progesterone* which (1) inhibits the production of gonadotropin by the pituitary, thereby preventing the development of another Graafian follicle, and (2) prepares the mucous lining of the uterus to receive and nourish the fertilized egg. However, if the cow was not served or, if served did not conceive, the corpus luteum begins to degenerate in about 15 days and the secretion of progesterone is stopped, whereupon the pituitary gland again begins the production of gonadotropin to start the process all over again.

Should the cow be served during estrus and the ovum be fertilized, the corpus luteum remains in the ovary throughout pregnancy and continues to produce progesterone, which prevents the development of Graafian follicles and hence, the occurrence of estrus. Normally the corpus luteum atrophies within about 6 weeks following calving, at which time preparation for the resumption of the estrus cycle takes place. Occasionally the corpus luteum fails to atrophy at the normal time after calving, inducing temporary sterility. Such a "retained" corpus luteum is commonly termed an *ovarian cyst*. If the cyst is expelled from the ovary, which can be done by a veterinarian or an experienced herd-man by working through the rectum, the cow usually begins estrus within a few days, after which she can be served.

Estrus and Conception. From the standpoint of the practical cattleman, the process of reproduction begins with the onset of estrus in the heifer. Ordinarily this condition, known as puberty, is first observed in heifers soon after they reach 1 year of age, although some heifers reach puberty while still nursing and thus are in danger, if a bull is running with the herd, of being bred when they are as young as 6 to 8 months of age. Liberal feeding appears to hasten the advent of puberty and scanty feeding tends to retard it.

A few hours after the end of estrus an egg is liberated by the rupture of a Graafian follicle, thereby presenting the conditions for conception and pregnancy. The interval between the end of estrus and ovulation varies from 6 to 20 hours (Table 33), whereas the time required for the male sperm to travel from the vagina to the oviducts, where fertilization normally occurs, is only a few minutes. Consequently it is advisable to delay breeding until toward the close of the heat period, or even a few hours afterwards, to favor the presence of strong, vigorous sperm in the oviduct at the time the egg is liberated.

Table 33

THE TIME INTERVAL BETWEEN ESTRUS AND OVULATION IN BEEF COWS*

End of Estrus		Time of Ovulation		Interval Between End of Estrus and Ovulation	
Hour of Day	Number of Cows	Hour of Day	Number of Cows	Interval in Hours	Number of Cows
4–5 P.M.	2	10–11 P.M.	1	1–2 hours	0
6–7 P.M.	7	12–1 A.M.	0	3–4 hours	0
8–9 P.M.	7	2–3 A.M.	0	5–6 hours	2
10–11 P.M.	7	4–5 A.M.	0	7–8 hours	1
12–1 A.M.	10	6–7 A.M.	1	9–10 hours	0
2–3 A.M.	4	8–9 A.M.	7	11–12 hours	8
4–5 A.M.	2	10–11 A.M.	5	13–14 hours	8
6–7 A.M.	0	12–1 P.M.	5	15–16 hours	11
8–9 A.M.	0	2–3 P.M.	11	17–18 hours	6
10–11 A.M.	1	4–5 P.M.	5	19–20 hours	1
Total observations	40	6–7 P.M.	1	21–22 hours	2
		8–9 P.M.	2	26 hours	1
Mean ending of estrus, 10:30 P.M.		Total observations	38	Total observations	40
		Mean hour of ovulation, 1:00 P.M.		Mean interval observed, 14.6 hours	

* Adapted from *Journal of Animal Science*, 1:192.

Since the duration of estrus in cattle is very short, seldom exceeding 18 hours, to delay breeding too long may result in the cow's being out of heat if natural mating is attempted. In studies made at the Michigan station with beef cows, 4 P.M. was the earliest and 10:30 P.M. the average time of day at which estrus ended. Hence it would seem that cows that are to receive only a single service should be bred in late afternoon. If two services are possible, one should be made soon after the cow is observed to be in heat, usually in the morning, and another attempted in the evening. Artificial breeding is most likely to be successful if insemination is made on the morning of the day after estrus. If hand mating in a breeding chute is practiced, bulls can be trained to serve cows the morning after estrus.

SIGNS OF ESTRUS. Cows vary greatly in their behavior during estrus. However, the condition can usually be detected by marked nervousness on the part of the animal and by her attempts to mount other members of the herd, which in turn often mount her. A close examination usually discloses a noticeable swelling of the labiae of the vulva, which often appear slightly inflamed in light-skinned animals.

As a rule estrus is accompanied by a slight mucous discharge. Rarely is there any loss of blood until a day or two after estrus, when a slight bloody discharge or "menstruation" sometimes occurs. Many herdsmen believe that the appearance of blood on the genitals, hips, or tail following breeding is an indication that conception has not taken place, but this theory is refuted by reliable research.

DURATION AND RECURRENCE OF ESTRUS. As has already been mentioned, the heat period of a cow is very short. While the entire time that she is in estrus may be as long as 24 or even 36 hours, the interval during which she willingly submits to natural service by a bull is generally much shorter, usually not over 12 hours. Seldom does estrus continue overnight or for longer than early morning until late afternoon; hence the saying by old herdsmen, "Breed a cow before she lies down."

Unless fertilization takes place, heat periods normally recur at intervals of approximately three weeks. There is some variation in the length of the estrus cycle even in the same individual. As a rule, however, it is seldom shorter than 18 or longer than 21 days. Cows that are to be bred should be closely observed at least twice a day during the third week following their last heat period.

Estrus, of course, does not normally appear during the period of pregnancy. Its occurrence at this time is often followed by abortion, although there are numerous instances on record in which pregnant

cows have been served in apparently normal heat periods with no ill effect whatever on the embryo. Normally about 6 weeks after parturition estrus again appears. However, few cowmen breed their cows so soon after calving. The common practice is to wait about 2 or 3 months, so that the calves will be born at the desired time in the calving cycle.

Age at Which to Breed Heifers. Inasmuch as the process of reproduction, and especially lactation, imposes a heavy tax upon the mother, heifers should not be bred until they are reasonably mature. Nature apparently provides that the growth of the fetus and care of the young shall take precedence over everything else, even over the requirements of the body of the mother for maintenance and growth. Whether or not arrested growth of the young cow, brought on by too early calving, is resumed later depends upon the treatment accorded the heifer after calving and lactation.

There is much evidence that gestation has a less stunting effect upon immature heifers than has lactation. This statement seems reasonable in view of the fact that the newborn calf contains only about 15 pounds of protein and 3 pounds of fat, whereas about 65 pounds of protein, 70 pounds of fat, and 90 pounds of carbohydrates are in the milk produced by the young mother during the first 4 months of lactation.[1] Consequently it appears that the average daily demands on the mother during lactation are several times greater than those during gestation. This fact has considerable importance in the accidental pregnancy of an immature heifer. If the heifer is not herself

Table 34

PRODUCTION RECORDS AT 8½ YEARS FOR COWS THAT CALVED FIRST AS TWO- AND THREE-YEAR-OLDS*

Age at First Calving	Two-Year-Olds	Three-Year-Olds
Number of cows compared	60	60
Number of possible calvings†	384	338
Number of calves weaned	350	298
Per cent calf crop weaned	91.1	88.2
Number of calves weaned per cow	6.4	5.3
Av. weaning weights, pounds (corrected for age and sex)	477	487
Cow cost/cwt. calf weaned ($)	10.02	11.73

* Oklahoma MP No. 48, 1957, p. 46.
† Considers the total number of times the cows should have calved. Per cent calf crop is based on this figure.

[1] California Extension Circular 131, 1946, pp. 100–101

If heifers are bred as yearlings to calve as 2-year-olds:

1. Size at first breeding is more important than age.
2. Total number of calves weaned and total weaned calf weight during a cow's lifetime favor breeding as yearlings provided necessary assistance is at hand during calving.
3. Heifers bred as yearlings may never reach normal mature size, especially if supplemental winter feed is low. In any case, maturity is delayed 3 or 4 years.
4. Average weaning weights of calves produced by heifers bred first as yearlings will be slightly lower than those of calves produced by heifers bred first as 2-year-olds.
5. Cow cost per hundred pounds of weaned calf favors breeding heifers to calve first as 2-year-olds.
6. More heifers will need assistance at first calving if bred to calve as 2-year-olds rather than as 3's.
7. Using Angus bulls to breed yearling Hereford or Shorthorn heifers is a worthwhile practice, if pasture calving is followed, especially if experienced assistance is not available during the calving season. The reason is that the resulting calves tend to be somewhat smaller at birth.
8. Level of supplemental winter feed has more effect on the weight of the cow than upon the weight of the weaned calf or per cent calf crop weaned, provided minerals, carotene, and protein are adequate in all cases.
9. The feed or pasture available during the nursing period affects weaning weight more than the age at which a heifer is first bred.

The choice of age at which first to breed heifers thus depends upon the ration available during the first winter as heifer calves, the level of management available during the calving season, and the quality and quantity of summer pasture available during the lactation period. Small ranch herds and farm herds tend to practice breeding as yearlings, whereas large spreads generally (but not always) breed heifers first as 2-year-olds.

The Breeding Season. The time of the breeding season, of course, depends upon when the farmer or rancher would most like his calves to be born. Since the average gestation period is 283 days, mating should begin approximately 9 months and 10 days before the earliest date on which calves are wanted. Although it is highly desirable to have all calves born as close together as possible, it will be found that, because of irregular estrus periods of some cows and failure of others to conceive from the first service, the period of calving, even in the better managed herds, usually extends over 2 or 3 months. Any

greater irregularity in the span of calving time is to be regarded as highly unsatisfactory, especially in a commercial herd. Bulls should be removed from the pastures within 4 months or less after the beginning of the breeding season. Actually, leaving the bull with the cows for 60 days gives each cow in the herd three opportunities to conceive, which should be enough if the bull is fertile and active throughout the breeding season. Pregnancy tests in the fall will reveal open or nonpregnant cows, which should be sold for slaughter.

Spring and Fall Calves. Insofar as possible, the commercial cattleman tries to have his calves born at a time when the weather conditions are most favorable. This means that they should be born either in the spring, after the cold weather of winter but before the heat and flies of summer, or in the fall, before winter has arrived. The exact calendar dates depend somewhat upon the latitude and, in the western states, upon the altitude as well. Table 36 shows the results of one study on the effect of birth month on survival, growth, and weaning weight of beef calves. By far the greater number of the calves of the country are born in the spring. However, some farmers, especially in the central and southern states, find it more to their advantage to have the calves dropped in the fall. Below are listed the principal advantages claimed for spring- and fall-born calves, respectively:

Advantages of Spring Calves

1. Dry cows can be wintered more cheaply.
2. Calves are of good age by winter and can stand cold weather better.

Table 36

THE EFFECT OF MONTH OF BIRTH ON THE SURVIVAL, GROWTH, AND WEANING WEIGHT OF BEEF CALVES*

Month	Number of Cows	Number of Calves	Percentage of Calf Crop	Average Age Weaned	Average Weaning Weight	Average Daily Gain	Percentage of Total
January	130	128	98.5	275	558	1.72	1.24
February	714	676	94.7	250	503	1.69	6.52
March	3,625	3,474	95.8	221	466	1.75	33.53
April	4,366	4,183	95.8	198	433	1.70	40.37
May	1,548	1,447	93.5	180	402	1.79	13.96
June	335	326	97.3	163	374	1.81	3.15
July	20	20	100.0	130	355	2.10	0.20
September	11	10	91	336	596	1.53	0.10
October	16	15	93.7	284	517	1.61	0.13
December	90	83	92.2	304	557	1.57	0.80

* Charles R. Kyd, Missouri Extension Service. Information to the author.

3. Cows milk better while on grass than they do on dry winter feed.
4. Labor is saved when cows and calves run together on pasture.
5. Calves may either be sold at weaning time with no wintering, or as yearlings with but one wintering.
6. Cows are bred while on pasture, when they are most likely to conceive.
7. A smaller investment in shelter and equipment is required.

Advantages of Fall Calves

1. Cows are in better physical condition for calving in the fall than in the spring, hence the calves are likely to be stronger.
2. Young calves escape the severe heat and the flies of midsummer.
3. Upon being weaned the calves may be turned on grass instead of being put in a dry lot; grass takes the place of milk to a considerable extent.
4. Cows that freshen in the fall milk longer than those that freshen in the spring. Spring grass stimulates milk flow in cows that calved the preceding fall, whereas changing to dry feed in the fall tends to diminish milk flow in cows that calved the preceding spring.
5. The greatest number of cattle are on hand during the winter season when labor for their care is available.
6. Cows are bred in the winter when hand mating is convenient.
7. Creep feeding, when practiced, is more convenient.
8. Calves are weaned at a more favorable marketing time, whether sold as stockers or as fat slaughter calves.

FIG. 28. Spring calves born on clean pasture are rarely affected by diseases or parasites. (Denver and Rio Grande Western Railroad.)

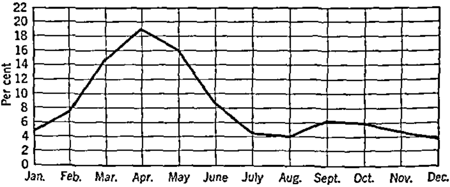


FIG. 29. Births of calves by months. Nearly 50 per cent of all beef calves are born during March, April, and May. (U.S.D.A.)

It will be seen that the advantages of spring calves have the most weight under extensive rather than intensive methods of cattle production. Fall-born calves, on the other hand, are particularly well suited to small farms where beef cattle are only one of the several enterprises that contribute to the income of the general farmer. Farms once equipped for dairying may well utilize their equipment and buildings with a fall calving program. In regions where winter small grain pastures are important, a fall calving system fits extremely well, because it enables the cow herd to utilize such pastures to the best advantage.

In some of the Western Range area, notably the Sandhills region in Nebraska, the practice of splitting the calving season into a spring and a fall season is increasing. Apparently this is being done because the ranchers believe they can sell more pounds of calf per cow with this combination. The fall-dropped calves are usually sold the following fall, weighing 600 to 700 pounds. In marketing circles these calves are called "calf yearlings." Another reason some give for this practice is that the ranchers select from the fall-dropped calves their heifer replacements for the main herd, which calves in the spring. This procedure enables them to compromise on the breeding date for the first-calf heifers since they will be calving at 2½ years of age. The replacements for the fall-calving herd come from the spring-dropped calves for the same reason. Naturally this system is adaptable only to herds large enough to make splitting the herd practical.

Methods of Mating. Three methods of mating are followed: hand mating, pasture mating, and artificial insemination. In hand breeding the bull is kept separate from the cow herd. Whenever a cow is observed to be in heat during the breeding season, she is turned in with the bull, where she remains until she is served; or, as is often

done in purebred herds, she is led into a level lot or into the breeding chute and held or tied while she is being served. The bull may or may not be managed by an attendant. As a rule, only a single service is permitted in hand mating and the cow is removed immediately after copulation.

Usually a bull is somewhat excited after he has bred a cow and will, if allowed to remain out in his lot, wear himself out by walking back and forth along the fence, seeking a way to come again with the cow. Consequently, it is advisable to return him to his stall in the barn for an hour or two until he quiets down. While in heat a cow should be kept away from the herd if practicable, whether she is served or not. Otherwise the entire herd is likely to be disturbed by her riding and being ridden by the other cattle. When such riding is done by cows well along in calf, abortion sometimes results.

In pasture mating the bull is allowed to run with the breeding herd throughout the breeding season. Data shown in Table 37 demonstrate that most of the cows which are easily settled will settle either from the first or second service. The table also shows that even after six estrus periods 27 per cent of the cows were still not settled. These cows doubtless would be difficult to settle under any system of mating and should be culled.

Pasture mating saves the labor involved in the daily inspection of the herd for cows that are in heat and in driving them to the breeding

Table 37

THE CALCULATED ESTRUS PERIOD AT WHICH COWS CONCEIVED DURING A BREEDING SEASON WITH PASTURE MATINGS*
(Data from U.S.D.A. Experiment Station, Jeanerette, Louisiana)

Estrus Period (20-day Basis)	Number of Cows Conceiving	Percentage of Herd: 100% Fertility		73% Fertility	
		For Period	Cumulative	For Period	Cumulative
1st	295	52	52	38	38
2nd	155	28	80	20	58
3rd	61	11	91	8	66
4th	30	5	96	4	70
5th	10	3	99	2	72
6th	3	1	100	1	73
Total: 120 days (4 months)	563	100		73	

* *Journal of Animal Science*, Vol 3, p 156

pen for service. Moreover it precludes the possibility of a cow's "going by" unbred because of the failure of the herdsman to detect her estrum. The objections to pasture mating are the following:

1. All cows that run in the same pasture are bred by the same bull, or by any one of several bulls if there is more than one bull present. This makes it impossible to be certain of the sire of each calf. This information is essential in herds on performance test or in purebred herds.

2. Bulls wear themselves out by repeatedly serving the cow while she remains in heat. Sometimes as many as six or more services are performed. Because of this tax on the bull's energy he can settle fewer cows. Instances are not uncommon in which immature bulls are rendered permanently sterile through excessive copulation.

3. If two or more cows are in heat at the same time the bull may give all his attention to one of them, allowing the others to go unbred.

There is little doubt that in a herd of commercial cattle the disadvantages of pasture mating are more than balanced by the saving of labor involved and the greater certainty of getting all cows in calf.

FIG. 30. Pasture mating of 2-year-old heifers. Labor requirements are low whereas conception rates are high in healthy cattle thus bred on lush spring pasture. (American Hereford Association.)

With purebred cattle, however, pasture mating is less widely used. Here, certain knowledge as to whether a cow has been served, the particular bull performing the service, and the date on which it occurred is so important, especially for sale cattle, that many purebred breeders resort to pasture breeding only as a check on their cows after they have been hand bred. Pasture mating is also used to some extent in large purebred establishments where the number of bulls and pastures is such as to permit the division of the herd into lots of 15 to 25 cows, each with a bull at the head.

Artificial Insemination. Artificial breeding has not been practiced as widely by beef cattle breeders as it has by dairymen. No doubt the absence of an easy, objective method of measuring merit in beef cattle, comparable to the milk production records of dairy cows, has been largely responsible for the limited use made of this method of breeding. Performance tested beef bulls are now, however, being added to the bull studs of many artificial insemination associations. Owners of small commercial herds should by all means avail themselves of this service if practical.

Another and perhaps more important reason for the limited use made of artificial insemination by the practical cattleman is the difficulty of determining when beef cows are in heat. Beef cows that run together day after day are much less inclined to ride one another than are dairy cows which are stabled at night and turned together after being milked in the morning. The fact that the breeding season for beef cows generally comes at the time of year when they are on pasture, often on a remote part of the farm, makes it very difficult not only to determine each day which cows should be bred but to separate these cows from the herd and drive them to the barn or corral where they are to be inseminated. The daily sorting out of cows suspected of being in heat, driving them to the corral, confining them in the squeeze gate, and returning them to pasture result in a great deal of disturbance to both cows and young calves, which is harmful to the herd. Added to all these disadvantages is the fact that often a relatively low percentage of cows conceive at the first insemination Usually after 2 or 3 months of artificial breeding a bull is turned with the herd to settle the cows that are still open. As a result the next year's calves show much variation in age and weight, thereby complicating their feeding and management.

No doubt artificial insemination will be found satisfactory by the small breeder who owns only 4 or 5 carefully selected purebred cows or 8 to 10 high grades—too few to justify purchasing and keeping a really good bull. It is also of great value in large purebred herds by

permitting the mating of an outstanding sire to many more cows than he could handle by either hand or pasture breeding. Bulls owned in partnership can be used in several herds, often located hundreds of miles apart, by resorting to artificial insemination. Purebred breeders should know the rules of their respective breed associations before using this method of breeding, however.

Lastly, artificial insemination can be employed to advantage in prolonging the usefulness of valuable sires which, because of accidents or advanced age, can no longer perform natural service. The recent development of a technique for freezing semen so that it can be stored almost indefinitely in a "semen bank" shows promise of being one of the greatest advances of all time in the field of animal husbandry. Semen from very outstanding sires can thus be used to inseminate outstanding cows long after the sire's death, and enough semen can be stored to produce literally thousands of offspring.

Use of a Breeding Chute. The breeding chute resembles a narrow, single stall, merely wide enough to admit a mature cow easily The sides of the stall are surmounted by 2- by 10-inch planks at such a height as to permit the bull to support himself on his front legs during service. This, of course, relieves the cow of supporting the bull's weight. Breeding chutes are especially valuable when young heifers are mated with an old, heavy bull. Chutes are also used in breeding cows that exhibit outward signs of estrus yet refuse to stand for service, and cows can be force-bred the following morning if not bred on the day of estrus.

It should be stated that some bulls absolutely refuse to work in a breeding chute, whereas others that have long been accustomed to a chute almost refuse to serve cows outside it. Occasionally a bull is found that, because of some peculiar conformation of abdomen or sheath, has difficulty in performing service unless the hind-quarters of the cow are lowered. This can easily be done by digging a hole at the rear of the chute and standing the hind feet of the cow in this hole.

Directions for constructing a breeding chute, with an illustration of it, may be found in Chapter 27.

Number of Cows Per Bull. The number of cows that can be successfully bred by a single bull depends upon, first, the age of the bull, and second, the manner in which the cows and bull are handled. A yearling bull may be allowed an occasional service but in no case should he be mated with more than 12 or 15 cows during a breeding season of 2 or 3 months. Two-year-old bulls are capable of caring for 25 to 30 cows and a bull 3 years old or over can be counted on to

Table 38

EFFECT OF BULL-COW RATIO ON LENGTH OF CALVING PERIOD*

Cows per Bull	Number of Herds	Number of Cows	Average Calf Crop (per cent)	Length of Calving Period: Average (days)	Minimum Period: Number of Cows in Herd	Minimum Period: Days	Maximum Period: Number of Cows in Herd	Maximum Period: Days
20 or less	5	756	95.4	77	51	53	455	99
21–30	36	3,682	94.5	102	101	41	110	219
31–40	12	1,223	93.1	118	34	46	80	212
Over 40	12	2,027	93.6	132	82	73	110	243

* Compiled from Mimeographed Reports of Kansas Beef Production Contest, 1946–1950 inclusive, Kansas Extension Service.

handle 40 to 50 cows if hand mating is practiced. If pasture mating is followed these figures should be reduced by about one-third. In no case should a bull under 15 months of age be allowed to run with his cows. Instead, hand mating should be used and but a single service allowed per cow.

As the size of the herd is increased, more bulls should be provided in relation to the number of cows since there is always a tendency for a large herd to break up into small droves of 10 to 50 cows each. The number of bulls in the herd should be sufficient to make sure that there is little chance of any such drove of cows remaining long without a bull.

Table 38, compiled from published records of the Kansas Beef Production Contest, indicates that more than 25 cows per bull is likely to result in a calving period that extends over 4 to 6 months or even longer, if the bulls are left with the herd until all the cows are settled. If they are removed earlier some of the cows will not have been bred and will produce no calves the following year.

uterus. It has many blood vessels which lead into the placenta. The amnion is a membrane that begins at the navel and surrounds the fetus like a sac, enclosing it entirely. It contains a liquid which serves to protect the fetus from external injury. In the cow there are about 6 or 7 quarts of this liquid, which is called the *amniotic fluid.* During parturition the amniotic fluid serves to lubricate the vagina; thus aiding in the expulsion of the fetus. The allantois is a large membranous sac, between the chorion and the amnion, containing the fetal urine. The urine enters the allantois through a tube from the fetal bladder, called the *urachus.* All of these membranes, taken together, constitute the fetal membranes or "afterbirth."

The Placenta. The term *placenta* refers to those portions of the fetal membranes and their annexes that serve to unite the mother and the fetus. Although there is no direct vascular connection, the blood vessels of each lie very close together so that an interchange of materials can be effected through their extremely thin, extensive walls. The capillaries of the fetal membranes, especially those of the allantois, which penetrate the chorion, become imbedded in the mucous walls of the uterus where they come in contact with the capillaries of the uterus. Through their walls "there is a free interchange of nutritive and waste products, but not of cellular elements The separation of the fetal from the maternal circulation is so complete that most microorganisms of disease do not ordinarily pass through."[1]

This penetration of the capillaries of the fetal membranes into the walls of the uterus is by no means general over the entire surface of the impregnated horn. Rather, such contact is made only at certain specialized areas known as *cotyledons* or *maternal placentae,* which are illustrated in Fig. 31. These areas are merely small prominences resembling scars or warts in the non-pregnant cow, somewhat oblong in shape, with their long axis at right angles to the long axis of the Fallopian tube. Since there are 40 to 60 cotyledons in each horn the cow is said to have a multiple placenta.

During pregnancy these cotyledons greatly enlarge and numerous follicles or depressions form on their surfaces, as seen in Fig. 32. Into these follicles the villi of the chorion and the other fetal membranes are inserted, thus making an extensive and extremely close attachment between the fetus and the mother. These groups of villi of the fetal membranes are termed the *fetal placentae.* Since each fetal placenta surrounds and "dovetails" into a maternal placenta, it follows that the fetal and maternal placentae are present in equal numbers. Between the placentae the chorion is free from the walls of the uterus.

[1] W. L. Williams, *Veterinary Obstetrics,* 1917, p 128.

chapter 7

PREGNANCY, PARTURITION, AND CARE OF THE YOUNG CALF

Inasmuch as estrus normally precedes ovulation by several hours, the spermatozoa of the male usually have sufficient time to reach the oviducts, where they await the liberation of the ripened egg. Normally fertilization occurs in the infundibulum of the tube, although there may be times when it does not take place until the egg reaches the uterus. The length of time required for the ovum to traverse the Fallopian tube is not definitely known but probably is approximately 10 days. During this time the fertilized egg, now known as a zygote, is undergoing division or segmentation. While increasing little, if any, in size, the egg by successive steps of cleavage divides first into 2, then 4, 8, 16, 32, and so forth, segments, finally reaching a condition known as the morula, or mulberry, stage. Soon after reaching the uterus the zygote becomes greatly enlarged by the absorption of fluids, and segmentation proceeds at a very rapid rate. Also the cells begin to exhibit marked differences in size and shape, first assuming the appearance of well-defined layers; later, the differentiation of cells and tissues to form the different systems of organs of the embryo takes place.

For the first 5 or 6 days the segmented zygote lies free within the uterine cavity, but shortly thereafter it becomes attached to the walls of the uterus. This attachment not only serves to protect the embryo from sudden and violent displacements during pregnancy, but also affords a method for the transfer of nutritive material from the mother to the young, and the contrary transfer of waste products, thereby making possible growth and development. As soon as this exchange of materials begins to take place the embryo is called a *fetus*.

The Fetal Membranes. The fetal membranes consist of three separate structures or parts: the *chorion*, the *amnion*, and the *allantois*. The chorion is the outer membrane surrounding the fetus and lies close to the mucous membrane of the uterus. The surface of the chorion is much greater than that of the impregnated horn. Consequently, it may extend into the non-pregnant horn, as well as into the body of the

uterus. It has many blood vessels which lead into the placenta. The amnion is a membrane that begins at the navel and surrounds the fetus like a sac, enclosing it entirely. It contains a liquid which serves to protect the fetus from external injury. In the cow there are about 6 or 7 quarts of this liquid, which is called the *amniotic fluid.* During parturition the amniotic fluid serves to lubricate the vagina; thus aiding in the expulsion of the fetus. The allantois is a large membranous sac, between the chorion and the amnion, containing the fetal urine. The urine enters the allantois through a tube from the fetal bladder, called the *urachus.* All of these membranes, taken together, constitute the fetal membranes or "afterbirth."

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This penetration of the capillaries of the fetal membranes into the walls of the uterus is by no means general over the entire surface of the impregnated horn. Rather, such contact is made only at certain specialized areas known as *cotyledons* or *maternal placentae,* which are illustrated in Fig. 31. These areas are merely small prominences resembling scars or warts in the non-pregnant cow, somewhat oblong in shape, with their long axis at right angles to the long axis of the Fallopian tube. Since there are 40 to 60 cotyledons in each horn the cow is said to have a multiple placenta.

During pregnancy these cotyledons greatly enlarge and numerous follicles or depressions form on their surfaces, as seen in Fig. 32. Into these follicles the villi of the chorion and the other fetal membranes are inserted, thus making an extensive and extremely close attachment between the fetus and the mother. These groups of villi of the fetal membranes are termed the *fetal placentae.* Since each fetal placenta surrounds and "dovetails" into a maternal placenta, it follows that the fetal and maternal placentae are present in equal numbers. Between the placentae the chorion is free from the walls of the uterus.

[1] W. L. Williams, *Veterinary Obstetrics,* 1917, p. 128.

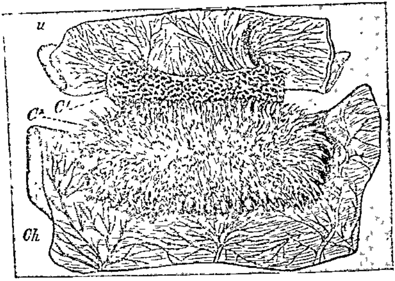

FIG. 31. Cotyledon of cow, showing relation of the maternal and fetal circulations: *u*, uterus, *Ch*, chorion; C^1, maternal, and C^2, fetal, portion of cotyledon. (After drawing by Colin.)

The Umbilical Cord. The bond of union between the fetus and the placenta is termed the *umbilical cord*. Practical stockmen usually refer to it as the navel string. Its sheath is composed of amniotic membrane within which are found two umbilical arteries, two umbilical veins, and the urachus, the tube that leads from the urinary bladder into the allantois. Interspersed between these vessels is a gelatinous mass called the *Whartonian gelatin*. The umbilical arteries carry the blood from the fetus to the capillaries of the fetal placenta, while the veins carry it back. These blood vessels have very strong

FIG. 32. Cotyledon of cow, showing the crypts of the maternal portion (bottom) and the tufts of the fetal portion (top).

muscular walls which contract forcefully when ruptured at calving time to prevent excessive bleeding. Since the umbilical arteries are attached to the umbilical ring only by loose connective tissue, their severed ends retract within the abdominal cavity of the calf upon being ruptured at birth. This retraction prevents the entrance of disease-producing bacteria through the severed vessels. It also serves to check the flow of blood. The umbilical veins, however, are attached firmly to the umbilical ring and do not retract when severed. Instead they remain open for a time and are occasionally the avenue for pus-forming bacteria.

Position of the Fetus in the Uterus. In the early stages of its development the embryo floats freely in the amniotic fluid, occupying no distinct position. With the growth of the fetus, however, it becomes fixed in position, usually with the anterior end, or head, toward the cervix. As the end of gestation approaches, the weight of the fetus is such that it rests upon its side upon the abdominal floor of the mother. Because the available space in the abdominal cavity of the cow is limited, the fetus tends to occupy that part of the abdomen not taken up by other organs. Since the rumen or paunch occupies the entire left side, the fetus must arrange itself on the right.

Multiple Pregnancy. The cow, as a rule, is uniparous; more than one fetus seldom is formed in the uterus. However, twin calves occur occasionally, and triplets and quadruplets are not unknown When only one calf is present it usually occupies one horn of the uterus; with twins, each horn usually contains a calf. Should the fetal membranes of twin calves of opposite sexes become fused in such a way as to establish a more or less common circulatory system, the development of the reproductive organs of the female fetus is arrested. Apparently the hormones of the male are dominant over those of the female; or, as seems more likely, the male sex cells are the first to appear in the development of the two fetuses. Inasmuch as the fetal membranes of calves are very large and extensive, filling, even in a single birth, nearly the entire uterus, those of twins are almost certain to be in close contact and to become fused together. Thus heifer calves born twin with bulls are almost always likely to be sterile because of the imperfect development of their reproductive organs Such heifers are called *free-martins.*

Signs of Pregnancy. The gestation period of the cow is approximately 283 days. Long before this time, however, certain changes are observed in the pregnant female that indicate the existence of a developing fetus. Since a diagnosis of pregnancy is often of the greatest importance, every cattleman should understand clearly the

careful exploration discloses a large, thick, firmly stretched band which passes downward and forward into the abdominal cavity.

Importance of Pregnancy Testing. Examination of females for pregnancy at the end of the breeding season can be an important tool in the efficient operation of a beef cow herd because carrying non-pregnant cows for a full year without any return is one of the largest drains on profits. Table 39 shows the breeding and calving record of a grade herd in Colorado over a 5-year period.[2] All the females, including breeding-age heifers, were examined for pregnancy in the fall before winter feeding started and, except for the last year,

Table 39

EFFECT OF PREGNANCY TESTING UPON PER CENT OF CALF CROP DROPPED IN A COLORADO HERD*

				Per Cent Calf Crop Dropped	
Year	Cows Examined	No. Found Open	Per Cent Open	Without Pregnancy Testing†	With Pregnancy Testing‡
1952	343	62	18.1	80.2	98.6
1953	352	24	6.7	92.4	99.1
1954	406	22	5.4	92.9	98.2
1955	469	28	6.0	92.1	97.9
1956	539	94§	17.4	82.0	99.3

* Personal communication to the junior author from Dr. Lloyd C. Faulkner, Colorado State University.

† Calculated on the basis of number of breeding-age females exposed to the bull.

‡ Based on the number of cows remaining in the herd after selling the cows declared open upon pregnancy testing.

§ Not all the open females were sold in 1956 owing to the large number found to be open, but calving percentage is calculated as if they had been sold.

all open females were sold. Prompt disposal of the open females increased the annual net return of the remaining cows by approximately $8 per head by reducing the total winter feed bill. Experimental work has indicated, although not conclusively, that heritability plays a role in regularity of breeding, and vigorous culling of slow- or non-breeders has been shown to increase the breeding efficiency of a herd materially.

Duration of Pregnancy. The length of the gestation period of cows is approximately 9 months and 1 week. Most authorities agree

[2] Personal communication Lloyd C Faulkner, D V M , Colorado State University, and Mr Fred Farrar and Mr. Tom Lasater, Colorado ranchers, 1958.

means whereby pregnancy may be determined. Unfortunately none of the signs of pregnancy which can be observed by the layman is infallible during the first half of the gestation period. However, there are certain changes commonly observed in pregnant cows which at least form a good reason for suspecting pregnancy in any bred female that exhibits them. As the gestation period progresses, more direct signs of pregnancy appear, although even these are sometimes misleading owing to the presence of certain diseases which produce changes in the affected animal similar to those caused by a developing fetus. Only direct examination made after the third month of the gestation period discloses beyond doubt the presence or absence of pregnancy. Among the many signs of pregnancy are the following important ones:

1. Cessation of estrus or heat. After having seen a bull serve a cow it is an easy matter for the cowman to make a record of it and determine when estrus should again occur if the cow fails to conceive. If pasture breeding is practiced, an experienced person checks the herd periodically during breeding season in order to see if the cows are "passing over." If identifiable cows do not return or show estrus, he can be assured that the cows are being settled.

2. *A noticeable enlargement of abdomen and udder.* An enlargement of the abdomen is usually a good sign but not necessarily a foolproof one. On the other hand, as parturition approaches, the udder fills and teats firm up. First-calf heifers start sooner in udder development than mature cows as a rule.

3 Feeling the fetus by internal examination. To establish pregnancy beyond a doubt, manual examination or palpation should be made of the reproductive tract by way of the rectum and colon. Occasionally it happens that a fetus as young as 2 months old can be discovered by this method but examination after the third month is more reliable. The success of rectal palpation in pregnancy testing is possible because the non-pregnant uterus and ovaries lie just beneath the colon and can easily be felt through the wall of the large gut. In early pregnancy (3 to 6 months) the presence of the fetus can be felt beneath the floor of the colon. When gently pressed by the hand the fetus slips away as though it were floating in a liquid, which of course it is, but returns immediately to its original position. As the period of gestation advances, the uterus and ovaries are pulled down within the abdominal cavity owing to the weight of the fetus and accompanying fluids. In this state it generally happens that neither the uterus nor fetus can be felt by the examiner. However,

careful exploration discloses a large, thick, firmly stretched band which passes downward and forward into the abdominal cavity.

Importance of Pregnancy Testing. Examination of females for pregnancy at the end of the breeding season can be an important tool in the efficient operation of a beef cow herd because carrying non-pregnant cows for a full year without any return is one of the largest drains on profits. Table 39 shows the breeding and calving record of a grade herd in Colorado over a 5-year period.[2] All the females, including breeding-age heifers, were examined for pregnancy in the fall before winter feeding started and, except for the last year,

Table 39

EFFECT OF PREGNANCY TESTING UPON PER CENT OF CALF CROP DROPPED IN A COLORADO HERD*

				Per Cent Calf Crop Dropped	
Year	Cows Examined	No. Found Open	Per Cent Open	Without Pregnancy Testing†	With Pregnancy Testing‡
1952	343	62	18.1	80.2	98.6
1953	352	24	6.7	92.4	99.1
1954	406	22	5.4	92.9	98.2
1955	469	28	6 0	92.1	97.9
1956	539	94§	17.4	82.0	99.3

* Personal communication to the junior author from Dr. Lloyd C. Faulkner, Colorado State University.

† Calculated on the basis of number of breeding-age females exposed to the bull.

‡ Based on the number of cows remaining in the herd after selling the cows declared open upon pregnancy testing.

§ Not all the open females were sold in 1956 owing to the large number found to be open, but calving percentage is calculated as if they had been sold

all open females were sold. Prompt disposal of the open females increased the annual net return of the remaining cows by approximately $8 per head by reducing the total winter feed bill. Experimental work has indicated, although not conclusively, that heritability plays a role in regularity of breeding, and vigorous culling of slow- or non-breeders has been shown to increase the breeding efficiency of a herd materially.

Duration of Pregnancy. The length of the gestation period of cows is approximately 9 months and 1 week. Most authorities agree

[2] Personal communication Lloyd C Faulkner, D.V M., Colorado State University, and Mr. Fred Farrar and Mr. Tom Lasater, Colorado ranchers, 1958.

It must not be supposed that the pregnant cow needs no exercise. Indeed, the opposite is the case. Except during cold, stormy weather there is no better place for her than out of doors where she can move about freely. In the winter months in cold climates she should, of course, be stabled at night the same as any other animal. However, a windbreak and a dry place in which to lie are all the shelter that she requires until she approaches her date for calving.

Signs of Parturition. During the last few days of the gestation period certain changes occur in the pregnant animal that signify to the experienced observer that parturition is not far off. The more important signs that are commonly observed are the following:

1. A relaxation of the pelvic ligaments (sacro-sciatic ligaments), which permits the muscles of the rump to drop inward, causing a noticeable falling away or sinking about the tail head and pin bones, and a general softening or loosening of the flesh in this region.
2. An enlargement and thickening of the lips of the vulva, which appear swollen and somewhat inflamed.
3. A noticeable enlargement of the udder and a somewhat sudden change in the contents of the udder from a watery secretion to the thick, milky colostrum.

These changes are usually discernible some 3 or 4 weeks before birth occurs but become more and more pronounced as the time of parturition draws near. As a rule they appear sooner in heifers than in old cows, the latter sometimes calving with little or no "notice."

Labor Pains. The act of birth is accomplished through much exertion on the part of the mother and is accompanied by intense pain. This pain is a perfectly natural phenomenon and in this respect is quite unlike all other pains and sufferings, which are due entirely to unnatural causes. The term "labor pains" is used to refer not only to the actual pain experienced by the mother, but also to the periodic muscular contractions which it provokes.

The first labor pains are usually of a colicky sort and give rise to the contraction of the uterine muscles only. Their advent usually occurs several hours before parturition and is indicated by a noticeable uneasiness on the part of the animal. Often the animal turns her head to the side, glancing nervously to the rear. Frequently she lies down and gets up at short intervals, thereby showing that she is in distress.

These preliminary contractions of the uterus are extremely important inasmuch as they result in shifting the fetus from a lateral, recumbent position on the floor of the abdomen to a longitudinal, upright atti-

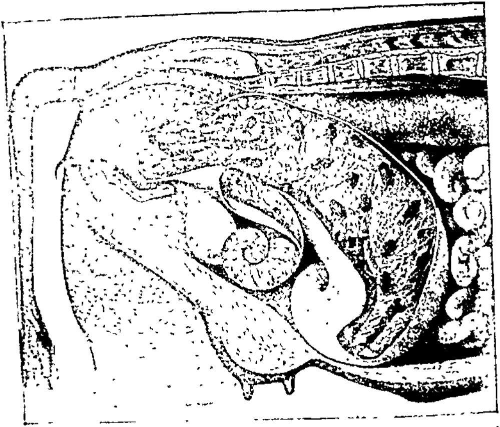

FIG. 33. The normal position of the fetus at the time of birth. (After Skelett.)

The effect of this great pressure upon the fetus is to cause it and its enveloping membranes to be displaced backward through the dilated os into the vagina. The chorion, or outer membrane, firmly attached to the walls of the uterus except near the fundus, does not permit much displacement and is soon ruptured by the increasing pressure. This step in the process of birth is highly essential to the well-being of the young, since the continuation of close contact between the chorion and uterus makes possible proper nourishment of the fetus throughout the time of parturition. With the rupture of the chorion, the allantois with its contained liquid escapes into the vagina to appear at the vulva as a "bright glistening tumor of more or less bluish tinge, separating the vulvular lips."[3] Gradually the contained straw-colored liquor escapes beyond the vulva to form a bladder varying in size from a pint to a quart vessel. This bladder is called the first "water bag." Usually it increases in size until it ruptures from the weight of the contained liquid.

It is very important that this water bag be allowed to break of its own accord. Upon the escape of the allantoic fluid, the pressure exerted by the uterus and the abdominal muscles is applied directly to the fetus suspended only in the amniotic fluid. Should this pressure be applied before the fetus attains its proper position or before the genital passages are sufficiently enlarged, the difficulty of birth is greatly increased. Hence, the longer the water bag remains intact the better.

Normally the rupture of the water bag is closely followed by the appearance of the amniotic bladder (second water bag) with the contained fetus. This membrane is glistening white in color and contains a rather viscid, slimy, opalescent liquid. Within this membrane can plainly be seen the presenting portion of the fetus, usually the front feet. With each labor pain more and more of the liquid is forced out to form a bladder which, upon bursting, materially lubricates the genital passage. The rupture of the amniotic membrane is followed by violent throes and strainings on the part of the cow, which soon force the head and then the shoulders of the fetus through the pelvic canal. At this stage the cow often proceeds to get on her feet, during which act the rest of the calf emerges under the influence of gravity.

Rendering Assistance. Assistance should not be given except when it is actually necessary. Some herdsmen are prone to rush in and "take" the calf by force at the first appearance of the water bag through the vulva. Such a practice is to be strongly condemned because injury is likely to be sustained by both cow and calf in the

[3] DeBruin, *Bovine Obstetrics*, 1897, p. 67.

form of torn membranes and strained ligaments. If no progress has been made toward delivery within approximately 2 hours after the beginning of labor pains, a careful examination should be made, by a veterinarian if possible, to ascertain whether or not an abnormal presentation is the cause of the delay. If this situation is found to exist, a veterinarian or an experienced herdsman should be sent for with all possible haste.

While unnecessary aid is to be strongly discouraged, one should not make the opposite mistake of permitting the cow to labor until she is completely exhausted before aid is furnished. Occasionally a calf is encountered with an abnormally large head or with unusually heavy shoulders which greatly delay or totally obstruct the passage through the pelvic cavity. Also, in a posterior presentation (hind feet first), the hips of the calf very frequently cause trouble, largely because of the small size of the allantoic bladder in the region of the hind-quarters, which results in insufficient opening of the cervix. In either event assistance should be given by fastening small ropes well above the calf's pasterns, to avoid injuring the soft hoofs, and pulling backward and downward each time the cow labors. No more force should be exerted than is necessary to overcome the obstruction. Under no condition should traction be applied except when the cow labors, unless she is exhausted to the point where she refuses to labor. If the cow does refuse, the calf must be removed wholly by the traction exerted by such helpers as are available.

So long as no tension is exerted upon the umbilical cord, there is no cause for hastening the act of birth. However, when the head has advanced as far as the eyes the cord becomes pressed against the floor of the pelvis in such a way that the placental circulation is jeopardized. Hence at this point it is highly advisable to rupture the amnion, if it is still intact, to permit respiration and to prevent the calf from drowning in the contained fluid. Since respiration is not likely to be effective so long as the chest is in the vice-like grasp of the genital passage, birth should be hastened by traction in such situations. In a posterior presentation there is always considerable danger of the calf's suffocating through rupture or strangulation of the umbilical cord. Consequently assistance in hastening parturition is much more likely to be necessary in posterior than in anterior births.

Care of the New-Born Calf. After the calf is born it is a good plan to clear all membranes from its nostrils to facilitate breathing. In case parturition has occupied a long interval and intra-uterine respiration has occurred, haste should be made to clear all amniotic

liquid from the nasal passages and throat. This can usually be accomplished by holding the calf head-down for an instant to permit the material to drain out, after which artificial respiration should be begun at once and continued until breathing is started. Many calves that appear to be dead can be revived by this method.

Because of the shortness of the umbilical cord (12 to 15 inches), it is always ruptured during the act of birth—usually about the time the fore-quarters pass through the vulva. If proper sanitary precautions have been taken in preparing clean quarters for the parturient cow, or if the cow has calved on clean pasture, there is little likelihood of any trouble from navel infection. However, some cattlemen make a practice of applying either tincture of iodine or formalin to the navel stump to destroy any pus germs that may be present. Others dust the stump with antiseptic powder to hasten its drying and sloughing off.

As soon as possible after birth, the cow and calf should be left alone. The cow apparently derives great satisfaction from drying her calf by licking it. Apparently this "labial massaging" is nature's form of artificial respiration. Also, it greatly stimulates the functioning of the calf's circulatory system.

Usually the calf stands and nurses of its own accord. The taking of nourishment a few minutes after birth is neither necessary nor advisable. If at the end of 5 or 6 hours the calf has not nursed, however, it should be given assistance in finding the udder. Seldom is more than one lesson necessary. Most authorities agree that the colostrum, or first milk, acts as a mild purgative on the digestive tract of the young calf, causing a more rapid discharge of the accumulated excretion in the intestines, known as meconium, than would otherwise occur.

Cows calving in midwinter should be accorded the best shelter that the farm affords. Otherwise the newly born calves may freeze before drying off or they may suffer from frostbitten ears and tails in zero weather. In summer very young calves should have access to some sort of shade to minimize the discomfort caused by oppressive heat. At other seasons calves are quite as well off out of doors as inside except during stormy weather.

It is highly important that young animals receive plenty of sunshine and exercise. Both are necessary for health and rapid growth. Calves born on pasture naturally get sufficient exercise in following their mothers back and forth over the pasture. Fall- and winter-born calves, not having this advantage, should be provided with a good-sized well-drained lot in which they may scamper and run on nice

days when the ground is dry or frozen. In addition to this lot a small paved pen on the south side of the barn is highly desirable as a "sun parlor" on days when the larger lot is wet and muddy.

Expulsion of the Afterbirth. After the calf is born the outer fetal membranes are still attached to the walls of the uterus by means of the cotyledons. With parturition, however, the exchange of nutritive elements between the maternal and fetal placentae immediately stops. With the stoppage of this circulation there is a shrinkage of the villi of the cotyledons, which results in loosening the attachments between the chorion and the uterus. This loosening is greatly hastened and facilitated by the contractions of the uterus, through which the uterus returns to its normal size. One by one the fetal placentae separate from the cotyledons of the uterus and the freed portion of the membranes is gradually forced out through the vulva by the contractions of the uterus. With the severance of the last attachment the whole mass of freed membranes drops to the ground. The expelled placenta should be removed promptly from the stall or lot as soon as observed and destroyed by burning or burying.

Retention of the Afterbirth. Normally the fetal membranes are expelled 2 to 6 hours after parturition. If they remain longer than 10 or 12 hours it is exceedingly likely that an abnormal condition exists and that manual assistance will be required in their removal. Cattle are more susceptible to this condition than are any other species of domestic animals, and it is by no means uncommon to encounter herds in which nearly 20 per cent of the cows are troubled with this affliction during some calving seasons.

The exact cause of the retention of the placenta is not definitely known. Some authorities regard it as a disease of the fetal membranes which causes them to adhere with abnormal tenacity to the maternal placentae. In all probability the majority of cases are due to the presence of infection which causes inflammation and enlargement of the maternal cotyledons. With their enlargement, the finger-like villi of the fetal membranes are gripped fast in the recesses of the uterine cotyledons, thereby preventing normal separation of the membranes. Such infection may have been present before parturition, as in contagious abortion, or it may have occurred while assistance was being rendered in an abnormal presentation. Also, retention is very likely to accompany a failure of the uterine walls to contract promptly, as a result of a general weakness on the part of the animal or its exhaustion from an especially long and painful parturition. Cows that are thin and half-starved, as well as cows that are in high show condition, are likely to be troubled with retained placentae

after calving. A deficiency of carotene, the precursor of vitamin A, or of vitamin A itself, in the ration of the pregnant cow has been linked with retained placentae. Such a deficiency is most apt to occur with cows being wintered on dead grass following one or more seasons of severe drought.

A retained placenta is an ideal medium for the development of putrefying bacteria. Almost invariably a string-like portion of the unexpelled membranes hangs from the vulva, where it comes in contact with the tail and hind-quarters of the cow. It, of course, becomes heavily laden with all sorts of bacteria which quickly spread into the interior. Decomposition and putrefaction begin in a remarkably short time. Except in cold weather an obnoxious odor, warning the owner that attention is urgent, appears within 48 hours after parturition. This odor becomes more and more pronounced until, at the end of a week or 10 days the stench is fairly nauseating.

The effect on the cow of acting as host to countless millions of putrefying bacteria soon becomes apparent. The absorption of the toxic products of decomposition causes her to take on an unthrifty appearance. She shows a marked decrease of appetite and a gradual loss of body weight; her milk flow is scanty or fails entirely; her skin loses its pliableness and her hair becomes harsh and dry; her eyes, instead of being bright and alert, become dull and listless. Altogether the cow gradually acquires a haggard, unthrifty, run-down appearance which may continue for months until she finally dies or recovers. Recovery is generally slow and is usually accompanied by sterility.

Removing Retained Placenta. If the fetal membranes have not come away within 24 hours after calving, immediate steps should be taken to retard their decomposition, pending their ultimate removal. For this purpose, bismuth subnitrate, iodoform, and other feebly soluble disinfectants suspended in mineral, olive, or raw linseed oil may be introduced, preferably by means of gelatin capsules.[4] Sulfa drugs and antibiotics of the proper kind are also recommended.

Considerable difference of opinion exists among practicing veterinarians as to the proper time to remove a retained placenta. Some recommend its removal as soon as 24 hours after calving. Others advocate waiting another day in order that the attachments may be partly loosened by the process of decomposition. Still other authorities advise postponement until the fourth or fifth day after calving to permit the uterus to contract sufficiently to enable the operator to

[4] W. L. Williams, *Diseases of the Genital Organs of Animals*, 3rd edition, 1913, p. 568.

reach readily all parts of the affected horn. However, seldom in a case of retained placenta does the uterus show any tendency to contract, while on the other hand, the cervix tends to close. Delay not only increases the likelihood of permanent injury to the uterus but also results in a more disagreeable and dangerous task from the standpoint of the operator because of more advanced decomposition of the membranes. Even though some delay may be advisable for one of the reasons stated above, an early examination is highly desirable since it is very important that the afterbirth be taken away as soon as it can be removed without injury to the uterus.

If possible the services of a trained veterinarian should be obtained for removing a retained placenta. The inexperienced operator who attempts to carry out printed instructions is very likely to damage seriously the walls of the uterus, especially the cotyledons. Moreover the danger of the layman's introducing harmful bacteria into the uterus, as well as infecting himself through a cut or skin abrasion on the arm, is very great. Few laymen realize the importance of observing proper sanitary precautions throughout the operation. Others go to the opposite extreme and use strong antiseptic solutions that sear and deaden the tender membranes of the genital tract. Under no condition should the layman attempt to remove a retained placenta until he has seen several removed by trained practitioners and has learned from actual experience and observation the exact method of procedure. Instead he should send for a veterinarian or an experienced herdsman who he knows is qualified to perform the operation. To do otherwise will almost certainly result in the sterility of the animal.

Irrigation of the Uterus. In cases of retained placentae, as well as other diseased or injured conditions of the genital tract, it is usually advisable to inject a mild antiseptic solution into the uterus. Care should be taken that the solution used is not too strong. It should be kept in mind that the membranes lining the genital organs are very delicate and are easily injured by strong medicines. A solution that is irritating causes the cow to strain, and such straining may result in the prolapse or eversion of the uterus. Probably the best antiseptic for the cow is a ½ per cent solution of carbolic acid (approximately 1 tablespoonful of carbolic acid per gallon of water). Creolin or lysol in 1 per cent solution, or potassium permanganate in a dilution of 1 to 2,000 is also satisfactory. Corrosive sublimate (mercury bichloride) should not be used because of its caustic properties. Care should be taken, in preparing any of these solutions, to guard against excessive strength. Probably the safest and most satisfactory

irrigant for the layman to use in all cases of diseased reproductive organs is a normal salt solution made by dissolving 1¼ ounces (approximately 2 tablespoonfuls) of common salt in a gallon of boiled water.

As a rule, the solution injected should be at body temperature. Exception is made when pronounced contraction of the uterus is desired, in which case the solution may be made with moderately cold water. The injection can best be made through a ⅜-inch rubber tube, fitted at the outer end with a funnel. Most veterinarians use a special aseptic enema pump by means of which the solution is forced into the uterine cavity under moderate pressure

Usually sufficient solution is injected to fill the genital tract completely. When this condition is reached the liquid escapes from the vulva as fast as it is poured in through the funnel. After the removal of the tube the cow should be watched carefully to see whether or not the solution is expelled by the forceful contraction of the uterus. If the animal does not throw out the injected liquid, it must be siphoned out as completely as possible. To leave the uterus full of liquid would impose upon its muscular walls an undue strain which might permanently lessen their contractile power. Especially is this likely to occur when irrigation is carried on daily over an extended period.

Occurrence of Estrus after Parturition. As a rule cows do not show signs of estrus until some 6 or 8 weeks after parturition Some cows even go longer before coming in heat. Although the calving dates of some cows can be advanced a few weeks each year, dependence upon this method for bringing about earlier calving in an entire herd of cows usually ends in disappointment. Late calvers should be culled or the average calving date may become still later. As previously mentioned, late-dropped heifer calves should ordinarily not be retained for breeding purposes because regularity of breeding may be heritable. For the same reason such heifers should not be sold to other breeders.

Size of the Calf Crop. The term "calf crop" refers to the percentage of cows in the breeding herd that produce calves of weaning age in a given 12-month period. This percentage often varies widely between different herds and in the same herd in different years. The more important factors that determine the size of the calf crop are the following:

1. Small percentage of pregnancies due to:
   a. Failure to detect cows in heat if hand mating is practiced.

Instead the crop is likely to lie somewhere between 70 and 95 per cent, as shown in Table 40. As a rule the size of the calf crop varies inversely with the size of the herd, owing to the smaller amount of individual attention that the animals of larger herds receive.

However, studies carried on by the United States Department of Agriculture, both in the Corn Belt and range areas, indicate that good care and management on the part of the owner are much more important factors in determining the percentage of calves raised than the size of the breeding herd or even the ratio of bulls to cows. In many instances great variation was found to exist in the size of the calf crop on practically adjoining ranches "with no perceptible difference in range, feed, water facilities, quality of animals, or animal losses." Undoubtedly such differences are largely due to the care with which the breeding herd is culled for non-breeding cows, the amount of attention given to the conditioning of bulls previous to the breeding season, the amount of time spent in systematic inspection of the herd for in-heat cows, and the attention given the cows during the calving period. Nevertheless, even with the same system of management, considerable variation in the percentage of calves raised was found to occur on the same farm or ranch from one year to another Weather conditions, particularly as they affect the feed supply of the cow herd and the exposure to which the young calves are subjected during the 2 or 3 weeks following birth, are largely responsible for

Table 41

THE INFLUENCE OF SIZE OF CALF CROP UPON THE NET COST PER CALF*
(North Central Texas Ranches.)

Per Cent Calf Crop (by Groups)	Number of Ranches in Each Group	Number of Calves	Net Cost per Calf (4 yr. aver.)	Per Cent of Total Calves
30–40	1	590	$43.92	1.4
40–50	2	585	49.21	1.3
50–60	14	11,880	36.15	27.4
60–70	18	8,020	38.88	18.5
70–80	22	10,848	28.03	25.6
80–90	22	9,749	25.46	22.5
90–100	5	1,095	22.15	3.9
Totals & Averages	84	43,367	$31.95	100.0

* California Bulletin 458.

these yearly variations. These can be overcome to a large extent by providing sufficient feed supplies and adequate shelter facilities to meet such emergencies.

The influence of the size of the calf crop upon the net cost of raising calves to weaning age is well illustrated by Table 41. Attention is called to the fact that 68 per cent of these Texas ranches realized a calf crop under 80 per cent. In sharp contrast with these figures are the records made by over 100 small breeders in the North Central states, many of whom weaned calves from 90 per cent or more of their cows (Table 42). In view of the fact that the size of the calf crop decreased gradually from east to west, it seems probable that feed conditions and available shelter were the chief causes for the variations noted. The data in both of these tables were obtained several years ago when many breeders, especially large ranchers, gave less attention to their herds than they do now.

Table 42

PERCENTAGE OF CALVES RAISED IN CORN BELT HERDS*

State	Number of Farms	Aver. Number of Cows per Farm	Aver. Per Cent Calf Crop
Indiana	6	16.5	96.2
Illinois	13	21.0	89.3
Missouri	33	22.1	90.2
Iowa	76	31.1	86.5
Minnesota	12	21.7	85.0
South Dakota	6	30.2	86.4
Kansas	46	30.4	81.5
Nebraska	38	27.0	79.9
Total	230	31.6	81.9

* U.S.D.A. Report 111.

chapter **8**

PRINCIPLES OF FEEDING BEEF CATTLE

Ruminant animals such as beef cattle are usually found on farms and ranches which, either because of choice on the part of the operator or because of necessity due to low rainfall, erosion problems, or infertility of the soil, produce large quantities of roughage and/or pasture. Ruminant animals, so called because they ruminate or chew cuds, have special adaptations in their digestive systems which enable them to utilize roughages or feeds which contain comparatively high levels of crude fiber or cellulose and related compounds. An understanding of these special adaptations is of value in determining feed or nutrient requirements of beef cattle, and by the same token an understanding of nutrient requirements is essential for proper ration formulation.[1]

Significant Features of Ruminant Nutrition. Monogastric animals, or those having simple stomachs, such as the pig and man, have a relatively low-capacity alimentary tract consisting of stomach, small and large intestines, and accessory glands. Digestion in these animals is largely of an enzymatic nature and little provision is made for either handling or digesting roughages; hence the diet of such animals must consist largely of concentrates or feeds low in crude fiber. In contrast, ruminant animals have compound stomachs and a much more complex digestive system, and much remains to be learned about their anatomy and function. Productive research work with the artificial rumen and the rumen fistula in the live animal is shedding much light on the so-called darkest spot in animal nutrition, the rumen.

The most successful cattle feeders today are those who understand

[1] The nutrient requirements of beef cattle, established through worldwide research, are regularly reviewed by the Sub-Committee on Beef Cattle Nutrition of the National Research Council (of which the author is a member). Recommendations published by the Sub-Committee in its 1958 revision of *Nutrient Requirements of Beef Cattle* have been used for reference in this chapter.

and take advantage of the following significant features of the ruminant animal:

1. The Four-Compartment Stomach. The *rumen* or paunch, the first compartment, constitutes about 80 per cent of the total stomach capacity in adult cattle and may hold up to 50 or 60 gallons. Connected with the paunch are the second and third compartments, the *reticulum* or honeycomb and the *omasum* or manyplies, which constitute 5 and 7 or 8 per cent of the total stomach capacity, respectively, in mature animals. All three of the compartments thus far mentioned have a common opening or passageway called the *esophageal groove*, through which materials may pass freely. The function of the reticulum is not too well understood, but it is known that the omasum is the site where much water is absorbed from the paunch contents prior to its passage into the fourth compartment, the *abomasum* or true stomach. The abomasum holds about 7 or 8 per cent of the total stomach contents, and this compartment is similar in function to the stomach of simple-stomached animals.

2. Symbiotic Microorganisms of the Paunch. Because the paunch provides an ideal environment such as proper temperature, moisture, nutrient supply, et cetera, for bacterial life, literally billions of bacteria—up to 100 billion per gram of dried paunch contents—and protozoa live in the paunch, to the mutual benefit of both the microbial life and the host animal, the ruminant. This mutual benefit or support is known as symbiosis. The breakdown of cellulose and related compounds by the enzymes produced by these symbiotic microorganisms accounts for the higher feeding value of roughages when fed to ruminants. Volatile fatty acids are produced as a result of the microbial fermentation of carbohydrates in the paunch. The most important of these acids, in terms of amount of acid produced, are acetic, propionic, and butyric, in that order. It has been estimated that from 40 to 50 per cent of the carbohydrate portion of beef cattle rations may be converted to these acids and absorbed directly from the paunch, after which they are metabolized to be used as energy or stored as fat. Thus fatty acids are a major source of energy in ruminant rations, as contrasted with the situation in simple-stomached animals, in which carbohydrates are largely absorbed as glucose after digestion in the stomach and small intestine.

3. Bacteria Synthesize Protein in the Rumen. As bacteria and the other microorganisms living in the paunch of the ruminant animal multiply, they build or synthesize the protein required for new cells. They make use of whatever source of nitrogen is present in the feeds

consumed by the host animal. The bacterial protein thus synthesized in the rumen is digested later in the true stomach and intestine and absorbed by the host animal in the form of amino acids, regardless of the source or quality of the protein or nitrogen consumed in the ration. Thus microorganisms play an important and significant role in protein utilization as well as in carbohydrate utilization in the ruminant. In contrast, the non-ruminant animal has specific requirements for approximately 10 of the amino acids, which are the building blocks of protein material. These specific amino acids are called the essential amino acids, and their balance, or presence, in required proportions, in a feed protein determines the *quality* of the protein for the non-ruminant.

Since the microflora of the paunch are not specific in their source of nitrogen or protein, low-quality proteins or proteins not balanced with respect to essential amino acids are well utilized by the ruminant. Furthermore, non-protein nitrogenous compounds such as urea, ammonium salts, and amides can make up a substantial portion of the total nitrogen or protein requirement of the ruminant. Such non-protein nitrogenous compounds as urea may be a cheaper source of nitrogen than the usual protein concentrates, and thus it is sometimes possible to formulate more economical protein supplements for cattle than for non-ruminant animals.

4. Vitamins of the B-Complex Are Synthesized by the Bacteria of the Rumen. Just as the microflora of the rumen are able to synthesize protein, they also synthesize many of the vitamins required by the host animal. Once the rumen becomes functional and a typical bacterial population is established, B-complex vitamins such as riboflavin, niacin, pyridoxine, biotin, folic acid, and B_{12} are synthesized in the rumen at a rate sufficient to meet the needs of the host animal. The rate of synthesis of certain of these vitamins can be altered by varying the level of certain nutrients in the rations consumed. For example, if cobalt, one of the essential mineral elements, is deficient in the ration, vitamin B_{12} synthesis is too low for maximum performance on the part of the host animal. Vitamin K, one of the fat-soluble vitamins, is also synthesized in the rumen, but such important fat-soluble vitamins as A, D, and E must be supplied in the ration.

Factors Affecting Microbial Activity in the Rumen. A more thorough understanding of the interrelationship between rumen microflora and the host animal has led to the concept that, in order to feed ruminants adequately or, in this case, to feed beef cattle, the nutrient requirements of the microflora should first be met. It is quite well

and take advantage of the following significant features of the ruminant animal:

1. The Four-Compartment Stomach. The *rumen* or paunch, the first compartment, constitutes about 80 per cent of the total stomach capacity in adult cattle and may hold up to 50 or 60 gallons. Connected with the paunch are the second and third compartments, the *reticulum* or honeycomb and the *omasum* or manyplies, which constitute 5 and 7 or 8 per cent of the total stomach capacity, respectively, in mature animals. All three of the compartments thus far mentioned have a common opening or passageway called the *esophageal groove*, through which materials may pass freely. The function of the reticulum is not too well understood, but it is known that the omasum is the site where much water is absorbed from the paunch contents prior to its passage into the fourth compartment, the *abomasum* or true stomach. The abomasum holds about 7 or 8 per cent of the total stomach contents, and this compartment is similar in function to the stomach of simple-stomached animals.

2. Symbiotic Microorganisms of the Paunch. Because the paunch provides an ideal environment such as proper temperature, moisture, nutrient supply, et cetera, for bacterial life, literally billions of bacteria—up to 100 billion per gram of dried paunch contents—and protozoa live in the paunch, to the mutual benefit of both the microbial life and the host animal, the ruminant. This mutual benefit or support is known as symbiosis. The breakdown of cellulose and related compounds by the enzymes produced by these symbiotic microorganisms accounts for the higher feeding value of roughages when fed to ruminants. Volatile fatty acids are produced as a result of the microbial fermentation of carbohydrates in the paunch. The most important of these acids, in terms of amount of acid produced, are acetic, propionic, and butyric, in that order. It has been estimated that from 40 to 50 per cent of the carbohydrate portion of beef cattle rations may be converted to these acids and absorbed directly from the paunch, after which they are metabolized to be used as energy or stored as fat. Thus fatty acids are a major source of energy in ruminant rations, as contrasted with the situation in simple-stomached animals, in which carbohydrates are largely absorbed as glucose after digestion in the stomach and small intestine.

3. Bacteria Synthesize Protein in the Rumen. As bacteria and the other microorganisms living in the paunch of the ruminant animal multiply, they build or synthesize the protein required for new cells. They make use of whatever source of nitrogen is present in the feeds

consumed by the host animal. The bacterial protein thus synthesized in the rumen is digested later in the true stomach and intestine and absorbed by the host animal in the form of amino acids, regardless of the source or quality of the protein or nitrogen consumed in the ration. Thus microorganisms play an important and significant role in protein utilization as well as in carbohydrate utilization in the ruminant. In contrast, the non-ruminant animal has specific requirements for approximately 10 of the amino acids, which are the building blocks of protein material. These specific amino acids are called the essential amino acids, and their balance, or presence, in required proportions, in a feed protein determines the *quality* of the protein for the non-ruminant.

Since the microflora of the paunch are not specific in their source of nitrogen or protein, low-quality proteins or proteins not balanced with respect to essential amino acids are well utilized by the ruminant. Furthermore, non-protein nitrogenous compounds such as urea, ammonium salts, and amides can make up a substantial portion of the total nitrogen or protein requirement of the ruminant. Such non-protein nitrogenous compounds as urea may be a cheaper source of nitrogen than the usual protein concentrates, and thus it is sometimes possible to formulate more economical protein supplements for cattle than for non-ruminant animals.

4. Vitamins of the B-Complex Are Synthesized by the Bacteria of the Rumen. Just as the microflora of the rumen are able to synthesize protein, they also synthesize many of the vitamins required by the host animal. Once the rumen becomes functional and a typical bacterial population is established, B-complex vitamins such as riboflavin, niacin, pyridoxine, biotin, folic acid, and B_{12} are synthesized in the rumen at a rate sufficient to meet the needs of the host animal. The rate of synthesis of certain of these vitamins can be altered by varying the level of certain nutrients in the rations consumed. For example, if cobalt, one of the essential mineral elements, is deficient in the ration, vitamin B_{12} synthesis is too low for maximum performance on the part of the host animal. Vitamin K, one of the fat-soluble vitamins, is also synthesized in the rumen, but such important fat-soluble vitamins as A, D, and E must be supplied in the ration.

Factors Affecting Microbial Activity in the Rumen. A more thorough understanding of the interrelationship between rumen microflora and the host animal has led to the concept that, in order to feed ruminants adequately or, in this case, to feed beef cattle, the nutrient requirements of the microflora should first be met. It is quite well

logical to assume that material passing too rapidly from the rumen (finely ground or chopped roughages, for instance) is not subjected to the normal cellulytic bacterial action.

Wastages in the Rumen. The products of fermentation and microbial action in the rumen are unfortunately not all used to advantage by the host animal. Ingested or ration protein and non-protein nitrogen compounds are partially converted to ammonia and volatile fatty acids in the rumen. Although much of the ammonia is utilized by microorganisms and converted to bacterial protein, variable amounts of ammonia are absorbed from the rumen into the bloodstream and either used in the synthesis of non-essential amino acids or wastefully excreted in the urine. Some of the absorbed ammonia may be re-excreted into the rumen by way of the saliva, where it may possibly be further utilized by the microflora. The extent of loss of protein or nitrogen accruing from excessive ammonia production in the rumen is not known, but undoubtedly it is affected by the level of protein in the ration, solubility of protein or nitrogenous material in the ration, type of carbohydrate in the ration, and concentration and character of microflora in the rumen.

The microbial fermentation in the rumen results not only in the production of volatile fatty acids from carbohydrate material which is used as energy but also in the formation of the gases, methane and carbon dioxide. Both these gases are normally eliminated by way of the esophagus and serve no useful purpose but rather represent a loss in energy from the ration.

Heat is also produced as a result of the fermentation taking place in the rumen. Only in very cold weather, especially in the absence of shelter, do cattle derive any benefit from this heat production. On the contrary, elimination of this heat may impose a burden upon the animal and thus be responsible for wasting still more energy because of restlessness and rapid breathing. A supposedly more efficient heat elimination system in Brahman cattle is said to explain this breed's superior adaptation to hot, humid climates.

NUTRIENT REQUIREMENTS OF BEEF CATTLE

The nutrient requirements of beef cattle closely parallel those of the microflora found in the rumen, at least from a qualitative standpoint. Since the requirements of both must be simultaneously supplied by the cattle ration it is rather difficult to assess the requirements separately. For practical ration formulation it is not necessary to do so. Quantitative nutritive requirements for rumen microorganisms have

established that the bacterial flora of the rumen consist of at least several dozen forms and that the relative distribution as well as total numbers present can be altered by changes in the ration. Certain forms are known to predominate if fattening-type rations, high in readily available carbohydrates, are being fed, whereas still other forms prevail when cattle are grazing lush pastures. Changing from one type of ration to another results in bacterial population shifts, but these shifts take place rather slowly, with the result that digestive disturbances may occur if type of ration is changed too abruptly. Undoubtedly this fact accounts partially for the poor performance, often amounting to actual weight losses, which results from shifting cattle from dry wintering rations to succulent spring pasture.

Protein or nitrogen level in the ration has a marked effect on the total digestibility of the dry matter of ruminant rations, and especially on the crude fiber. This level is extremely important, because differences in crude-fiber digestibility have an influence on the digestibility of the remaining nutrients in the ration which might be encased within the cellulytic cell walls of the fibrous portion of the plant.

The inclusion of a small amount of readily available carbohydrate such as ground corn or molasses in high-roughage rations has been reported to increase rumen microfloral activity and hence increase the feeding value of high-fiber roughages. If large amounts of such easily digestible carbohydrates are fed, as in finishing rations, the reverse happens—that is, crude-fiber digestibility is reduced—but in this type of ration the crude fiber content of the ration is relatively low.

Certain minerals, particularly phosphorus, sodium, potassium, sulfur, and cobalt, are essential for maximum microfloral activity. The relative availability or solubility of these minerals in the rumen seems to be involved, as well as the content of the ration, at least in the case of phosphorus

Certain feeds such as high-quality alfalfa and certain commercial fermentation by-products reportedly contain as yet unidentified factors which stimulate the activity of the rumen microflora. Ashing the alfalfa and feeding the ash as a supplement to low-quality roughage rations has been reported to increase the concentration of rumen bacteria and increase crude-fiber digestion.

Bulk in the ration, a term used in connection with the relative weight of a given volume of ration, undoubtedly plays a part in microfloral activity and therefore in digestibility of crude fiber. Bulk provides for distention of the rumen and enhances normal rumination and physiological function of the rumen itself. Indirectly, bulk is involved in rate of passage of material from the rumen and it is

logical to assume that material passing too rapidly from the rumen (finely ground or chopped roughages, for instance) is not subjected to the normal cellulytic bacterial action.

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not been determined, and more experimental information is needed before separate requirements can be established.

The nutrient requirements of beef cattle will be discussed from a broad viewpoint under the forthcoming headings, and specific requirements for different age groups and for the different feeding programs will be discussed in the appropriate chapters.

1. Feed capacity and bulk.
2. Energy.
3. Protein.
4. Minerals.
5. Vitamins.
6. Water.
7. Miscellaneous feed additives.

Feed Capacity and Bulk. Cattle should be fed to capacity under all ordinary feeding conditions. Regardless of whether the aim is maximum daily gain in a steer finishing program or only maintenance of dry cows, performance is more favorable if the complete ration, or at least one item in the ration, is fed to appetite. This procedure enables cattle to consume enough feed to satisfy their hunger and thus prevent the uneasiness and wasteful excessive movements associated with a limited ration.

Condition and age both affect feed capacity, and there is considerable variation between animals of the same condition or age. Cattle on finishing rations voluntarily consume each day feeds (air-dry basis) in amounts equal to 2.5 to 3.0 per cent of their live weight. Older cattle such as cows in good condition and fleshy individuals such as mature bulls, consume less, even as low as 1.5 per cent of their live weight. Thin, growthy, yearling or older steers may consume up to 3 per cent of their weight daily.

Certain additions can be made to the ration which increase consumption, especially if a major portion of the ration is unpalatable. An example is the addition of blackstrap molasses to a wintering ration consisting of a large percentage of ground corn cobs or other similar low-quality roughage. Such an addition to an already palatable ration increases intake only temporarily and serves later merely as a replacement for an equal weight of ration being fed prior to the addition.

Recent experimental evidence presented by Crampton et al.[2] would indicate that acceptance, or the level of voluntary consumption of a ration, is related to the digestible nutrient content of the ration; that

[2] E. W. Crampton et al., *Journal of Animal Science*, Vol. 16, 1957, p. 1056.

is, the more digestible the ration, the greater the daily consumption and vice versa. This line of reasoning would tie feed intake to the quality of the ration as well as to size, age, or condition of cattle.

Feeds high in water content, such as succulent spring pasture, winter small grain pastures, and high-moisture content silages, are consumed at a lower level of dry matter or air-dry feed intake because of their high water content.

A certain minimum amount of bulk or roughage is required to maintain feed intake at a constantly high level in the ruminant; otherwise bloat and other digestive disturbances will be frequent. The minimum roughage level in finishing rations is 0.5 to 0.8 pound per 100 pounds live weight daily or 20 to 30 per cent when expressed as per cent of the ration. Apparently roughages can provide the necessary bulk, even though finely chopped, if pelleted, as will be seen in the discussion in Chapter 26 dealing with preparation of feeds.

Energy. The energy requirements of beef cattle have been studied by various methods with the result that requirements are expressed in a number of ways. Specific requirements as used in this text will be given in terms of Total Digestible Nutrients (T.D.N.) and in terms of digestible energy. Daily requirements for this and other nutrients will be given, as will the required percentage content of the ration for all the various nutrients.

According to Morrison[3] the total digestible nutrient content of a feed is the sum of all the digestible organic nutrients—protein, fiber, nitrogen-free extract, and fat (the latter being multiplied by 2.25 because its energy value is approximately 2.25 times that of protein and carbohydrate). T.D.N. as a measure of the energy value of feeds is subject to some criticism. The principal objection is that T.D.N. is computed from data determined by the Weende proximate analysis procedure on the feeds consumed and feces excreted during a digestion trial. The objection arises from the fact that the proximate analysis procedure itself is subject to criticism. Then there is also the criticism that T.D.N. assumes an equal caloric or energy value for protein, nitrogen-free extract, and crude fiber, and a constant energy value for ether extract. The limitations mentioned are probably not serious from a practical standpoint, because the values for feeds and those appearing in tables giving nutrient requirements and feeding standards are all based on the same method of calculation.

The latest revision (1958) of "Nutrient Requirements of Beef Cattle," a report of the National Research Council prepared by the Sub-Committee on Beef Cattle Nutrition, expresses the energy require-

[3] F. B. Morrison, *Feeds and Feeding*, 22nd edition, 1956, p. 41.

ment of beef cattle in terms of digestible energy or calories as well as in T.D.N. The difference in the gross energy content of feeds consumed and the feces voided in a digestion trial is a measure of the digestible energy content of a feed or ration. Gross energy of both feed and feces is determined by combustion in a bomb calorimeter. The term "digestible energy" refers to a measure, expressed as therms, of the useful energy in a feed or ration. The feed tables included in the appendix contain values for digestible energy which were computed from existing T.D.N. values in feed tables as follows:

$$\text{Therms digestible energy} = \frac{\text{lb. T.D.N.} \times 454 \times 4.41 \text{ Kcal.}}{1{,}000 \text{ Kcal.}}$$

Digestible energy values and feed requirements computed in this fashion are only as reliable as the T.D.N. values from which they were computed. Actual rather than computed values should be determined and it is gratifying that research in this important field is being renewed with vigor.

A deficiency of energy, due to a simple lack of sufficient total feed, is undoubtedly the most common deficiency in beef cattle rations. The results of low-energy intake are slow growth or even loss in weight, stunting, failure to conceive, and increased disease and mortality. An energy deficiency is usually accompanied by deficiencies in all other nutrients but especially in protein. Overstocking of pastures and ranges, especially in periods of prolonged drought, is the principle cause of energy deficiency. Cattle on finishing rations may receive rations adequate in total amount or weight to meet appetite needs but still not perform up to their capabilities in terms of gain, owing to a lack of sufficient energy in the ration.

Protein. Protein requirements are usually expressed on the basis of per cent of both the total and digestible protein in the ration. In the tables given in the appropriate chapters, requirements are also given in terms of daily requirements for total and digestible protein. The digestible protein values are approximately equal to 60 per cent of the total protein for high roughage rations and to 75 per cent for high concentrate rations.

Ration nitrogen, from which bacterial protein can be synthesized in the rumen, can be supplied in non-protein nitrogenous forms such as urea, as previously mentioned. Under normal circumstances up to one-third of the total protein requirement may safely be supplied in non-protein nitrogenous forms.

Symptoms of protein deficiency in beef cattle are poor growth, depressed appetite, reduced milk flow, irregular estrus in cows and

delayed onset of first estrus in heifers, and loss of weight in extreme cases.

Minerals. The requirements for calcium and phosphorus are quite well established and numerous determinations for the content of these minerals in feeds have been made. Thus the requirements for these minerals and their sources are given in appropriate tables in this book. Requirements for other minerals, except for salt, are not so well established and hence are not included in the tables mentioned.

PHOSPHORUS. Phosphorus deficiency is the most common mineral deficiency and is most likely to occur in growing stocker cattle being wintered on all-roughage rations and in cows being wintered on mature, weathered grass. Phosphorus deficiency is usually associated with soils deficient in the element. Figure 34 shows that this mineral is deficient in the feeds being grown in large areas of the country.

In the early stages of phosphorus deficiency or when a borderline deficiency exists, feed intake is decreased, gain is reduced, and milk production falls off with a consequent reduction in suckling calf gains. Efficiency of feed utilization is reduced, and if the deficiency is

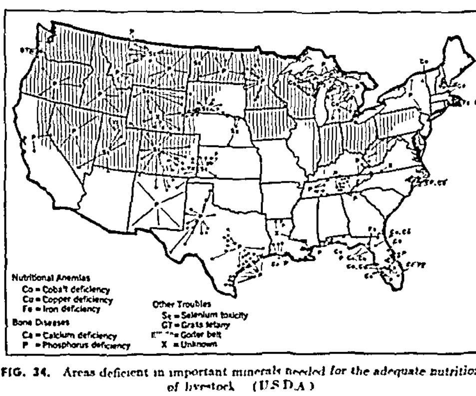

FIG. 34. Areas deficient in important minerals needed for the adequate nutrition of livestock (U.S.D.A.)

prolonged, blood phosphorus levels fall. Pica, or depraved appetite, results from severe prolonged deficiency and such severe deficiencies are usually accompanied by bone alterations which result in lameness and stiff joints.

As mentioned earlier, phosphorus may be one of the most critical nutrients for normal bacterial action in the rumen. Therefore requirements of both the microorganisms and the host animal must be supplied in the ration. The effect of the relative availability or solubility of the phosphorus supplement fed when required to balance the ration is not well established.

Calcium. A deficiency of this element is most apt to occur when rations high in concentrates, such as finishing rations, are being fed. This is especially true if the limited roughage portion of the ration is non-leguminous. If cows, especially those nursing calves, subsist principally on mature, weathered grasses or hay or cereal straw, they are almost certain to respond to calcium supplementation. Heavy corn silage rations are often borderline for calcium unless supplemented with legume hay. Calcium deficiency symptoms are not very specific except in extreme cases when fractures may occur due to depletion. Poor growth rate, inefficient feed conversion, and low ash-content bones are usually the result of low calcium intake. Calcium deficiency is often associated with energy, protein, and phosphorus deficiencies.

Experiments carried on at the Indiana[4] and Iowa[5] stations have shown practically no advantage in feeding calcium supplements to mature steers being fattened on well-balanced rations. However, the Kansas[6] station has shown that calves fed a non-leguminous, low-calcium roughage, such as prairie hay, should be supplied with finely ground limestone or some other mineral rich in calcium. Finely ground limestone fed at the rate of $\frac{1}{10}$ pound daily to calves gave much better results when fed with prairie hay than did either acid phosphate or bonemeal. As is seen in Table 43, no benefit was derived from the addition of ground limestone to the ration of calves receiving 6 pounds of alfalfa hay. When only 2 pounds of alfalfa were fed, the feeding of the limestone was profitable.

The calcium and phosphorus content of the principal supplements used to correct deficiencies of these elements is given in Appendix Table 2 The calcium:phosphorus ratio in beef cattle rations should fall between 2:1 and 1:2.

[4] Indiana Bulletins 281, 291, and 314

[5] Iowa Mimeographed Reports 116 and 117.

[6] Kansas Circular 151.

Table 43

VALUE OF ADDING GROUND LIMESTONE TO A LOW-CALCIUM RATION*
(375 lb. Calves, Fed 180 Days)

Kind of Hay Fed	Alfalfa Hay				Prairie Hay			
Other Roughage	None		Cane Silage		None		Cane Silage	
Mineral Fed....... ...	None	Ground Lime-stone	None	Ground Lime-stone	None	Ground Lime-stone	None	Ground Lime-stone
Daily gain, lbs.	2.46	2.44	2 32	2 49	2.15	2 25	2 07	2.43
Av. daily ration:								
Shelled corn.....	9.74	9 60	9.77	9.51	9 83	10 09	9 65	9.85
Cottonseed meal	1.12	1.11	1 00	1 00	1 36	1 40	1 16	1.16
Hay............	6.03	5 84	2 01	2 00	4.43	5.03	1 36	1.41
Cane silage. . .	...	....	9.71	10.05	.	.	8 91	10.14
Ground limestone	. .	11	. .	10	. . .	12	..	.10
Feed per cwt. gain:								
Shelled corn.	396	394	422	382	457	448	466	406
Cottonseed meal	46	45	43	40	63	62	56	48
Hay.....	245	239	87	80	206	223	65	58
Cane silage	..	.	419	401	.	. .	430	418
Ground limestone	...	5	.	4	.	5	.	4
Selling price per cwt.......	$13 25	$13.00	$12.75	$13.00	$12.50	$12.75	$12 50	$13.00

* Kansas Circular 151.

SALT. The salt or sodium and chlorine requirements of full-fed beef cattle are met by including 0.5 per cent salt in the total ration. Salt is usually fed free-choice, however, rather than as part of a mixed ration, with the result that more salt is actually consumed than is required.

Salt is essential to the growth and health of all kinds of livestock Cattle exhibit a special eagerness for it and soon show signs of restlessness and malnutrition if it is long withheld. The form in which the salt is fed has an effect upon the amount consumed Cattle that have free access to granulated or loose salt consume approximately twice as much as they would get from salt furnished in the form of 50-pound blocks. Whether or not enough is obtained from licking blocks kept in the feed bunk or in the pasture near the water supply is a disputed

subject among cattlemen. The flake form of salt is not to be recommended for use in the open, because of the large amount lost through weathering. At the Kansas station the flake form weathered 24 per cent per month, whereas the blocks weathered only 11 per cent. In those states having a heavier rainfall, greater losses may be expected. Cattle accounted for the disappearance of 604 pounds and weathering for 141 pounds of block salt exposed in pastures at the Illinois station from April 30 until October 21, or 175 days. The total disappearance of salt per 2-year-old steer was approximately 3 pounds per month. Little difference was observed at the Illinois station between the consumption of salt by yearling cattle wintered on good roughages in the dry lot and by the same cattle on good pasture the following summer.

The amount of salt consumed is greatly affected by the amount and character of the ration as shown in Table 44.

The use of salt to control supplement intake usually results in the consumption of considerably more salt than is required. As much as

Table 44

Salt Consumed by Beef Cattle under Different Feeding Conditions

Station	Reference	Feeding Conditions	Daily Consumption per Head, pounds: Barrel Salt	Daily Consumption per Head, pounds: Block Salt
Calves.				
Iowa	Leaflet 127	Full fed in dry lot	0.015	0 007
Kansas	Circular 265	Wintered on bluestem pasture	0 04	
		Wintered on sorgo silage	0 05	
	Circular 250	Wintered on sorgo silage and hay	0 06	
		Sorgo silage plus ½ feed of corn	0 03	
		Sorgo silage plus full feed of corn	0 013	
Montana	Bulletin 401	Wintered well on hay and straw	0 063	
		Limited amounts of hay and straw	0 183	
Yearlings				
Illinois	Unpubl. data	Wintered on hay and silage	0 18	0 096
Iowa	Leaflet 127	Full fed in dry lot		0 013[a]
	Leaflet 131	Full fed in dry lot		0 03[b]
Kansas	Circular 265	Full fed in dry lot	0 07	
Montana	Bulletin 401	Wintered well on hay and straw	0 08	
		Limited amounts of hay and straw	0 26	
2 year-olds				
Illinois	Unpubl. data	Bluegrass-ladino pasture		0 09
Iowa	Leaflet 110	Full fed in dry lot	0.012	0 018
Iowa	Mimeo. Report 1923	Full feed of corn with corn silage		
		No protein concentrate		0 04
		1 5 lb. protein concentrate		0 024
		3 0 lb. protein concentrate		0 013
		Full feed of corn with legume hay		
		No protein concentrate		0 07
		1 5 lb. protein concentrate		0 024
		3 0 lb. protein concentrate		0 025

[a] Average of 2 lots
[b] Average of 11 lots

2 pounds of salt may be consumed by cattle daily without harm, provided the animals have free access to an abundant supply of drinking water.

OTHER MAJOR MINERALS. Magnesium, potassium, and sulfur are required by cattle, but the specific quantitative requirements have not been determined. Deficiencies of these minerals have been produced on purified diets only. Experimental work in this area is limited, since the content of these minerals in the feedstuffs normally consumed by beef cattle is such that deficiencies do not naturally occur.

If urea supplies a considerable portion of the nitrogen in the ration, sulfur, either in organic or inorganic form, may conceivably prove beneficial as an addition since sulfur, or the sulfur-bearing amino acid methionine, has been shown to facilitate bacterial synthesis of protein in artificial rumen studies. Practical rations have not been improved by the addition of sulfur in numerous studies, which indicates that the sulfur content of such rations is adequate.

TRACE MINERALS. Trace minerals are those found in only minute amounts in soils and plants. The content of such minerals in feedstuffs is closely associated with their content in the soils from which such feedstuffs are grown. Figure 34 indicates areas in which it has definitely been established that the indicated trace mineral deficiencies may occur. It will be seen that areas whose soils are most subject to leaching, due to either heavy rainfall or permeability, also are more subject to mineral deficiencies.

Iodine deficiency is usually manifested by the production of goiterous calves which either are born dead or die soon after birth unless treated with iodine. The use of iodized salt containing 0.01 per cent of stabilized potassium iodide prevents deficiency symptoms. Seldom is non-iodized salt so much cheaper as to justify its purchase if the iodized form of salt is available.

Iron is undoubtedly required by beef cattle, but quantitative requirements are not established nor have consistent responses been obtained from its use in practical rations. Thus it may be assumed that feedstuffs consumed by beef cattle contain adequate iron.

Copper requirements for beef cattle are very low but are adversely affected by the molybdenum and sulfate content of the ration. A deficiency of copper can be prevented by adding 0.25 to 0.5 per cent of copper sulfate to the free-choice-fed salt. This practice insures a copper content of 4 to 8 parts per million (p.p.m.) in the total air-dry ration. Excess molybdenum apparently interferes with copper metabolism. Hence, in areas where molybdenum toxicity is evident, additional copper should be fed. Although copper deficiency is almost

exclusively a local problem, calves being fitted for show or sale by the use of nurse cows well beyond the normal time for weaning sometimes may develop copper deficiency. Generally poor performance along with intermittent to severe diarrhea and stunted growth are symptoms of copper deficiency. When copper deficiency is complicated by molybdenum toxicity, depigmentation of the haircoat is common.

Cobalt is required by rumen microflora to insure adequate vitamin B_{12} synthesis, since this element is an integral part of the B_{12} molecule. The requirement has tentatively been set at 0.07 to 0.10 milligram (m.g.) per 100 pounds body weight. It is generally supplied in the ration, when needed, in the form of cobalt sulfate added to the salt or mineral mixture at the rate of 1 ounce per 100 pounds salt.

Hay and pasture forage rations containing 0.01 to 0.07 p.p.m. of cobalt have resulted in cobalt deficiency, whereas if the cobalt content is in the neighborhood of 0.10 p.p.m., performance is normal. Thus the requirement, expressed as content of the diet, would be met by 0.10 p.p.m. cobalt in the ration.

Symptoms of cobalt deficiency, like those of many other mineral deficiencies, are general rather than specific. Severe deficiency results in reduced feed intake, emaciation, weakness, and even death. Perhaps of more importance is the borderline deficiency which may not be recognized and thus is not corrected. Such borderline deficiencies may result in generally reduced performance and inefficient feed conversion.

Manganese and *zinc* are undoubtedly required by beef cattle, but since forages contain 50 to 150 p.p.m. of manganese and 10 to 100 p.p.m. of zinc, the likelihood of a deficiency existing under practical conditions is remote.

Trace mineralized salt is available in most feed stores. The cost per unit of trace mineral may in some instances be quite high, and its feeding may be unessential. This statement is especially true if the rations being fed contain average to good quality roughages which are grown in areas where the soils are adequate in trace mineral element content. As indicated earlier, trace mineral deficiency is principally a geographical problem, and consultation with soils experts and nutritionists in such areas is necessary to determine if supplementation is needed.

Toxic Minerals. Some minerals, although they may actually be required in minute amounts, may produce harmful effects if ingested in excess of these requirements.

Fluorine, contained in either undefluorinated rock phosphate and mine washings or deposited upon the forage grown in areas subjected to fluoride-containing smoke, is toxic to beef cattle if consumed in

excessive amounts. The usual fluorine content of the mineral supplements fed to beef cattle is shown in Appendix Table 2.

Symptoms of fluorine toxicity are mottling and erosion of the enamel of the teeth and a softening and thickening of the bones, with a resulting decrease in breaking strength. The maximum level for fluorine in the ration has been recommended at not more than 65 p.p.m. for feeder cattle and not more than 30 p.p.m. for breeding cattle kept on such rations for extended periods of time.

Selenium toxicity is a local problem occurring primarily in the Dakotas and the Rocky Mountain States. Cattle consuming feeds containing 8.5 p.p.m. of selenium for a considerable length of time show symptoms of chronic toxicity. Death occurs if feeds consumed contain 500 to 1,000 p.p.m. of selenium. Characteristic symptoms of selenium toxicity are loss of appetite, sloughing of hoofs, loss of hair from the tail, and eventually death. No effective treatment has been determined other than removal of animals from the affected areas.

Molybdenum is apparently an essential mineral, but the requirement is low since more than 10 to 20 p.p.m. in forages result in toxic symptoms. Excess molybdenum exerts its effect by interfering with copper metabolism as previously mentioned. Until more information is available, molybdenum should not be added to beef cattle mineral supplements.

Vitamins. Vitamin deficiencies in general are much less apt to occur in cattle feeding than are mineral deficiencies. This is because, first, as mentioned earlier, most of the vitamins required by cattle are synthesized by rumen microorganisms, and, second, the feeds usually consumed by cattle are fair to excellent sources of those vitamins which must be supplied in the ration.

VITAMIN A AND CAROTENE. Requirements for this vitamin and its precursor, carotene, are expressed as both carotene and vitamin A in the requirement tables in the appropriate chapters. Approximately 1.5 mg. of carotene are required daily per 100 pounds of live weight for normal growth in young cattle. Dry pregnant cows and nursing cows require 3 to 4 mg. and 10 mg., of carotene, respectively, per 100 pounds live weight daily.

Vitamin A may be stored in the body during periods of high carotene intake such as occur during summer on lush pasture. These stores may be drawn on during winter and the amount stored, of course, affects the minimum level of vitamin A or carotene necessary in the winter ration. Another factor affecting the overall practical problem of vitamin A in the ration is that of instability or destruction of the carotene in feeds during storage due to oxidation.

Vitamin A deficiency in beef cattle is rather uncommon when good quality roughages are fed. However, in instances when a combination of poor hay and concentrates low in carotene content, such as old corn, small grains, grain sorghums, or molasses, make up the ration, vitamin A deficiency may occur. Extended periods of drought may result in forage deficient in carotene. Calving difficulties and breeding problems often occur in the spring following such a year. The estimated carotene content of cattle feeds is shown in the Appendix Tables.

Vitamin A deficiency symptoms are night-blindness (inability to adjust to sudden bright lights), incoordinated gait, and convulsive seizures in severe cases. Excessive lacrimation or watering of the eyes may also occur, but this symptom can easily be confused with watery eyes brought on by pink-eye (see Chapter 29) or by irritation from cinders and dust during movement or shipment of the cattle. Diarrhea, from severe to intermittent, in both young and older cattle may be a result of vitamin A deficiency but here, too, other causes for such diarrhea may cause confusion. A very characteristic deficiency symptom in feeder cattle is anasarca or generalized edema. The swellings are localized in the brisket area and in the knee and hock joints. Lameness usually accompanies the more severe cases of edema.

Sexual activity declines in bulls suffering from vitamin A deficiency; spermatozoa decrease in numbers and motility and increase in number of abnormal forms. In breeding cows, estrus may continue, but cows conceive less readily. Vitamin A deficiency in the pregnant cow may result in abortion if it is sufficiently severe. Calves may be born dead or weak, and retained afterbirths are common in deficient cows. A suspected vitamin A deficiency can be verified by analyses of blood or liver tissue for vitamin A or carotene content.

Vitamin D. A deficiency of this vitamin is extremely unlikely under practical conditions, because beef cattle receive sufficient vitamin D from exposure to direct sunlight or from the consumption of sun-cured hay. In areas of the country or world where days are extremely short or cloudiness persists most of the year, and especially during haying season, it is conceivable that a deficiency, especially in borderline form, may exist, but clear-cut cases of vitamin D deficiency are seldom reported.

The disease known as rickets, which results from poor calcification of bone, is the chief symptom of vitamin D deficiency produced under controlled experimental conditions. Posterior paralysis may result from fracture of vertebrae in very severe cases. Poor performance may result from borderline deficiency. Adequate vitamin D is essential for efficient calcium and phosphorus utilization and bone forma-

tion. Abnormally low levels of calcium and phosphorus in the blood, in the presence of adequate calcium and phosphorus in the ration, would support a suspicion of vitamin D deficiency.

VITAMIN E. Muscular dystrophy or white muscle disease in calves between the ages of 2 to 12 weeks is the chief symptom of a deficiency in vitamin E. Only certain geographical areas have reported this condition and it is not very widespread. The quantitative requirement, expressed as tocopherol, is tentatively estimated to be less than 40 mg. of tocopherol per 100 pounds of body weight daily.

In affected areas, losses due to muscular dystrophy in calves may be reduced by feeding 2 to 3 pounds of grain during the last 60 days of pregnancy, or by oral administration of tocopherol to both cow and calf shortly after parturition.

VITAMIN K. This vitamin is synthesized by the rumen microflora in adequate amounts under normal feeding conditions. Moldy clover hay and clover pasture sometimes contain dicumerol, a compound which prevents normal blood clotting. Therapy with vitamin K is usually effective in combating this condition.

B VITAMINS. Although requirements for most of the B vitamins such as riboflavin, thiamin, and biotin have been demonstrated for the young calf before it has developed a functioning rumen, attempts to improve the rations of cattle over 8 weeks of age with B-vitamin supplementation have not been generally successful. These vitamins, like vitamin K, are apparently synthesized by the microflora of the rumen at a rate sufficient to meet the needs of the animal. An example of how dietary nutrients may affect bacterial synthesis of B vitamins has been mentioned, namely the relationship between cobalt intake and B_{12} synthesis. Other such relationships may be discovered in the very active research programs being conducted in this field at the present time.

Water. Water, because of its abundance and universal use, is seldom regarded as a feed, and yet it is one of the most essential nutrients for all animal life. No cattleman would consider letting his cattle go without water for a single day, but many do not see that the water provided is clean, pure, and uncontaminated.

The amount of water required by cattle, exclusive of the water contained in the ration, varies with the character of the feed, the amount of dry matter consumed, and the air temperature. Data on the water consumed on different rations and by cattle of different ages are extremely meager, but enough are available to permit making a rough estimate of the daily water requirements of cattle full-fed in dry lot. It can be seen from Table 45 that as the season advances from winter

Table 45

WATER CONSUMED BY CATTLE FULL-FED IN DRY LOT

Station	Reference	Period	Daily Water Consumption, pounds	Consumption per 100 lb. Live Weight, pounds
Calves:				
Iowa	Bulletin 271	Feb. 4–14	26	4.8
		Mar. 5–15	27	4.4
		May 4–14	51	6.7
		July 3–13	65	7.1
Ohio	Bimonthly Bulletin 154	Apr. 15–Aug. 18	57	6.5
Yearlings:				
Iowa	Bulletin 271	Feb. 4–14	29	3.4
		Mar. 5–15	25	2.7
Illinois	Mimeo. Report, 1937	Aug. 5–19	92	8.8
		Aug. 22–Sept. 6	86	7.7
2-year-olds:				
Iowa	Bulletin 271	Feb. 4–14	36	3.4
		Mar. 5–15	33	3.0

Table 46*

TOTAL DAILY WATER INTAKE† AS AFFECTED BY TEMPERATURE AND LEVEL OF FEED INTAKE (DRY MATTER BASIS)

Temperature (Fahrenheit)			40°	50°	60°	70°	80°	90°
Gallons of Water per Pound of Dry Matter Intake			0.37	0.40	0.46	0.54	0.62	0.88
Body Weight (lb.)	Expected Daily Gain (lb.)	Dry Matter Daily (lb.)	(gal.)	(gal.)	(gal.)	(gal.)	(gal.)	(gal.)
		Cattle on Maintenance Rations‡						
400	0.0	5.4	2.0	2.2	2.5	2.9	3.3	4.8
800	0.0	8.8	3.3	3.5	4.0	4.8	5.5	7.7
1,200	0.0	11.8	4.4	4.7	5.4	6.4	7.3	10.4
		Wintering Weanling Calves						
400	1.0	9.9	3.7	4.0	4.5	5.3		
500	1.0	11.7	4.3	4.7	5.4	6.3		
600	1.0	13.5	5.0	5.4	6.2	7.3		
		Wintering Yearling Cattle						
600	1.0	14.4	5.3	5.8	6.6	7.8		
800	0.7	16.2	6.0	6.5	7.4	8.7		

* *Journal of Animal Science*, 15: 722-740 (1956).
† Total water intake includes both the water drunk and that contained in the feed.
‡ Animals that are neither gaining nor losing weight.

to summer the amount of water consumed per 100 pounds live weight increases rather sharply. Similar data, collected under controlled conditions by Winchester and co-workers of the United States Department of Agriculture, shown in Table 46, indicate that, in addition to temperature effect, increasing levels of feed intake result in the intake of more water.

Water should be kept slightly above freezing temperature during the winter by the use of insulated tanks and by tank heaters during extremely cold weather. *Electric, oil, or gas heaters are preferred* since they can be equipped with a control device which keeps the water at an even temperature of 40 to 50 degrees. The principal advantage of heaters is the labor saved in keeping the tanks free of ice, since cattle appear to thrive as well on ice-cold water as on water at moderate temperatures.[7]

[7] Oregon Bulletin 183.

chapter 9

THE SUMMER MANAGEMENT OF THE BREEDING HERD

In theory the feeding and management of the breeding herd during the summer are relatively simple, since the herd is then running on pasture and requires little attention. In practice, however, some of the cowman's most difficult problems arise during this season of the year.

First in importance is the difficulty of estimating the forage supply, which is determined largely by weather conditions and can neither be predicted nor controlled. Should the weather be unfavorable for the growth of grass, a critical shortage of feed may be encountered long before the usual end of the grazing season.

Second, the breeding season for most beef herds comes during the summer, which necessitates inspection of the herd regularly to insure that cows are being settled. Noting the dates on which a few familiar cows are observed to be in heat and then following up with an inspection 19 to 20 days later soon reveals whether or not the cows are being settled. *Farmers and ranchers are, however, invariably busy with field work at this time of year and are prone to limit inspections to once or twice a week, especially if the herd is on a pasture at some distance from the farmstead.*

Third, early summer is the proper time to castrate bull calves that were born on pasture or were too young to castrate while the herd was still in the dry lot. If this job is put off until the urgent field work is finished, the calves are big and hard to handle when it is finally done. The same situation is true for such jobs as dehorning, vaccinating, and branding, which may not get done before cows go to pasture if calves are not dropped early. Finally, a fourth summertime problem is the need for attention to such parasites as screwworms, hornflies, and deerflies. In the range areas and in farm areas which rely on farm ponds, water shortage can become quite as problematical as grass shortage.

Pasture. *Pasture is relied upon almost entirely for feed for the breeding herd during the summer months.* On most farms and ranches

no feed other than pasture is given. As has been previously stated, pasture is considered so essential for the breeding herd that few beef cows are kept by operators who do not have sufficient grass to carry them through the summer. This attitude on the part of stockmen is based upon long experience as well as upon scientific facts. In the first place, cattle on pasture are living under the most natural conditions that can be provided, and with no class of cattle is an approach to natural conditions so desirable as with the breeding herd. Cows with young calves instinctively seek seclusion, and nowhere else on the farm can they find it so well as in the pasture. Young calves need a large amount of milk and there is nothing better than grass to stimulate the milk flow during the lactation period. The first food other than milk that a young calf receives should be soft, palatable, and easily digested. Green grass fulfills all these requirements. Moreover, it furnishes an abundance of protein, vitamins, and minerals, three factors that are highly essential to the normal growth of young animals.

Both cows and calves need plenty of exercise, fresh air, and sunshine to keep them healthy and free from disease. Seldom are cattle troubled with lice, ringworm, pneumonia, or foul feet while they are on pasture. When kept in barns and small lots, on the other hand, these afflictions are frequently encountered. Whereas it seems most desirable that the breeding herd be kept on pasture during the summer for as long as forage is sufficiently plentiful to provide milk and nutritious feed for the calf, some successful operations are being carried on completely in dry lot. The year-round dry lot system offers an opportunity for maximizing the use of equipment and labor and for actually harvesting more forage, either as hay, green chop, or silage, from high-yielding cultivated pasture seedings.

KINDS OF PASTURE

As a rule, pasture areas are occupied by perennial plants, that is, plants that do not die after ripening their seed but continue to grow year after year. Kentucky bluegrass, redtop, brome grass, Bermuda grass, and nearly all the native grasses of the Western Plains region such as the bluestems, the gramas, wheatgrasses and buffalo, are perennials, and they together occupy by far the greater percentage of the total pasture area of the country. Of course such perennial legumes as alfalfa, white Dutch clover, trefoil, and ladino are desirable additions to pastures where they are adapted.

Temporary Pasture. During the past 20 years there has been a marked increase in acreage of temporary pasture crops, especially in

FIG. 35. An ideal pasture area for a breeding herd. The stand of grass has become thin, however, and has been partly replaced by weeds. Heavy disking, fertilizing, and reseeding will double the carrying capacity of this field within 10 years.

the Corn Belt where new seedings made in small-grain crops are allowed to stand for a year or two as part of the general crop rotation. These rotation seedings may be harvested for hay or grass silage the first year and pastured for a year or two thereafter before they are plowed under for corn. Or they may be left standing for only one year, in which case the first crop is sometimes cut for hay or grass silage and the second crop pastured. Or they may be grazed by beef cattle or other stock from early spring until late fall. Obviously the method of utilizing a particular field is determined largely by the need for additional pasture at the time it is ready to be used for that purpose.

The plant species most widely used in seeding temporary pastures consists largely of legumes, since the principal reason for including a year of pasture in the crop rotation is to improve the fertility of the soil. Consequently, alfalfa and red, alsike, and sweet clovers, either seeded alone or mixed with grasses, are commonly used. A mixture of red clover, sweet clover, and timothy is a very satisfactory seeding for a pasture that is to be utilized for only 1 year, but alfalfa usually should be included in seedings that are to be allowed to stand 2 years or longer.

Advantages of Temporary Pastures:

1. More feed is furnished per acre at any given time, making possible a larger herd for a given pasture area, especially if rotation grazed.
2. A large percentage, if not all, of the forage consists of legumes
3. Temporary pasture crops normally withstand the heat and drought of summer better than some perennial grasses.
4. The temporary pasture crop can be included in the regular farm rotation, thus making possible the utilization of the legumes grown primarily for soil improvement. At the same time those benefits accruing to the soil through pasturing and feeding on pasture are shared by different parts of the farm.
5. Any surplus forage can be utilized for hay or silage.

Of these advantages, the last two are of most importance The others, important in some years, are open to question when a long period of time, involving all kinds of seasons and weather, is considered It is undoubtedly true that with a good stand and ordinary weather conditions most legume-grass pasture combinations produce more and better forage than grasses alone on similar land. However, experience has shown that, under ordinary farming conditions, in not more than 4 years out of 5 is a perfect stand of legumes secured, whereas in about 1 year out of 7 or 8 the crop is almost a total failure At such times the

common practice is to sow oats, rye, Sudan grass, or other non-legume crops for pasture.

Since the advantages of temporary pastures have been mentioned it might, perhaps, be worth while to list the principal objections raised against them.

Disadvantages of Temporary Pastures:

1. They require an annual outlay for seed, preparation of seed bed, et cetera.
2. Stand of crop is often uncertain and sometimes a total failure.
3. Plants do not form a good turf; hence, the fields are often badly trampled in wet weather.
4. Adequate shade and water are provided with difficulty.
5. Temporary pasture crops are likely to cause bloat.
6. Tight fences are required around every field.
7. Some of the temporary pasture plants tend to ripen and dry up in late summer and early fall.

The last mentioned disadvantage can be dismissed with the statement that the clovers of the common, temporary pasture crops are biennial legumes which ripen and dry up only in the fall of the second year. By this time the seedling pastures started in the spring of that year are large enough to graze and the stock can be shifted to them. Likewise, the sixth objection can be met with the statement that all fields of the farm should be well fenced, whether in pasture or not, to permit the utilization of stalk fields, oat and hay stubble, et cetera, by cattle. Inclusion of alfalfa in the mixture overcomes the last mentioned disadvantage.

Table 47

Performance of Calves on Different Pastures

Kind of Pasture	No. of Cows	No. of Calves	Days on Pasture	Average Weaning Weight*	Average Total Gain of Calves	Average* Daily Gain of Calves
Bluegrass only	1878	1799	176	378	262	1.49
Bluegrass and lespedeza mixture	2235	2120	176	414	294	1.67
Bluegrass in spring and lespedeza in summer (alone or after harvest of small grain)	5847	5610	176	470	313	1.95

* Charles R. Kyd, Missouri Extension Service, information to the author.
* All lots weaned at an average age of 200 days.

It is obvious that temporary forage crops have a real place in cattle raising. However, it would appear that their greatest use is to supplement rather than displace permanent pastures. The danger of not securing a stand, and thus being without any forage, is too great for the farmer to rely exclusively on temporary pastures for maintaining a breeding herd.

The best plan in all but the range areas is to depend on neither permanent nor temporary pasture alone for maintaining the breeding herd but to provide enough of each to insure a continuous supply of nutritious, palatable forage throughout the summer. Especially is some permanent pasture advisable for use in early spring and late fall, at which seasons temporary pastures often cannot be used without damage to the stand because of wet weather. Permanent pastures, such as bluegrass and brome grass, which form a thick, dense sod, are damaged much less seriously both by extremely wet weather and occasional periods of severe drought, when all pastures become little more than exercise lots. Figure 36 is just one example of how a long-season pasture program can be developed to fit local area conditions.

Permanent pastures outside the range areas are usually ready for grazing earlier in the spring than temporary pastures, not only because they have a denser sod, but because they are lower in moisture and hence are less laxative. They are most productive during cool, moist weather and may be grazed heavily from the last of April to the middle of June. They are relatively dormant during July and August but make considerable growth in the fall upon the return of cool weather.

Most temporary pastures 1 year old or older are at their best in June, July, and August. Often they are so productive during the early summer that only a portion of the area is needed for grazing, and the remainder of the field may be cut for hay. The second crop comes on quickly and this fresh growth combines with the more mature forage of the grazed area to make an ideal pasture for beef cattle.

If temporary pastures are spring sown, as in the case of Sudan grass, which is seeded alone, or sweet clover, Korean lespedeza, or alfalfa, which are seeded in small grain, they are usually ready to be grazed by the last of July or the middle of August and furnish excellent grazing until the first killing frost.

Cattle should be removed from all legume pastures immediately after a killing frost because frozen legume forage may cause serious bloat and scouring. However, such pastures may be grazed with safety 2 or 3 weeks later after the stems and leaves have become dead and brown. Obviously legume pasture is much less palatable and nutritious after being frozen than it was while still green. Fortunately, at

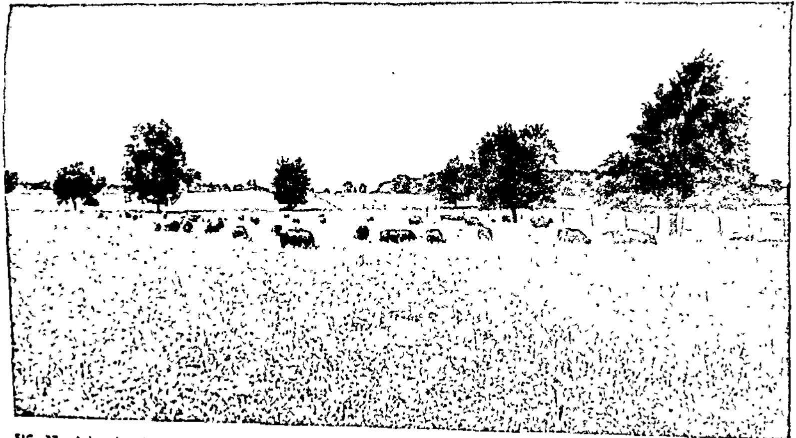

FIG. 37. A breeding herd on a rotation pasture. Such pastures, included as a part of the regular crop rotation, usually have a high carrying capacity because they are grown on fertile soil and consist largely of legumes. (American Shorthorn Association.)

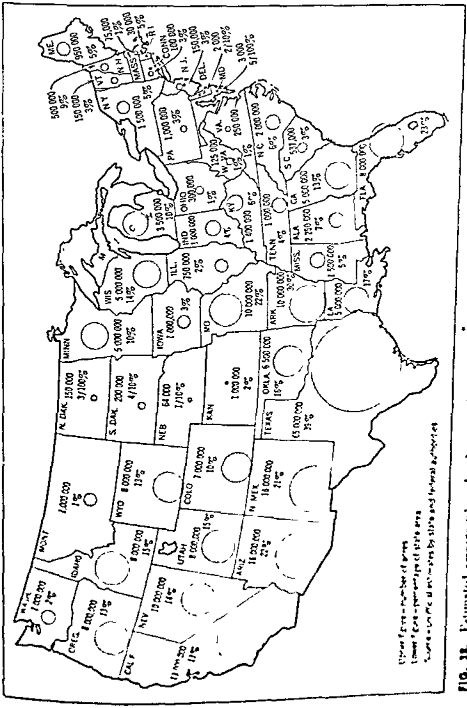

FIG. 38. Estimated acreage where brush removal can improve beef cattle gains in the United States. (Texas Livestock Journal)

pasture and have lost considerable weight from parturition and subsequent suckling. In much of the range country, weight loss occurs throughout the winter. These losses from all causes often amount to 150 to 200 pounds per cow. Half or more of these losses usually is regained during the first two months on pasture while the grass is fresh and abundant, and the remainder is regained during the fall and early winter after the calves are weaned. Frequently the cows lose in weight during the middle of the summer when the pastures are scorched and dry and the calves, now grown to good size, sap the strength of their mothers by their frequent nursing. One advantage of creep-feeding calves that run with their mothers on pasture is to relieve the cows of part of the burden that their offspring impose upon them during the latter half of the summer.

Supplementary Feed for Cows. Unless the pasture area used by the cattle is sufficiently large to insure the accumulation of a reserve supply of grass, it may be necessary during periods of drought to give the cows some feed in addition to that furnished by the pasture, if their milk flow and flesh are to be maintained. Some cattlemen follow the practice of guarding their supply of grass against possible exhaustion by supplementing the pasture with other feeds from the very beginning, or soon after the beginning, of the grazing season Such a practice is to be recommended on farms in the non-range area where the pasture acreage is small, since it makes possible the carrying of a greater number of cattle on a given area without exhausting the grass supply long before the normal end of the grazing season. Experience

Table 48

Effect of Supplementary Feed upon the Pasture Area Required per Cow and Calf*

Pasture Acreage per Cow and Calf (Bluegrass)	No. of Days Pastured	No. of Days Supplement Was Fed	Average Daily Supplement per Cow for Period Fed		Average Daily Supplement per Cow for Entire Period	
			Cottonseed Meal	Corn Silage	Cottonseed Meal	Corn Silage
			Lbs.	Lbs.	Lbs.	Lbs.
1.50	161	12	.52	15 6	.01	1 35
1.00	145	93	.35	14 0	.22	9 06
.50	161	153	.73	29.2	70	27 85

* Illinois Experiment Station; Average of three years' work.

and less nutritious annual grasses and brush compete for moisture and fertility. Burning reduces forage production in the long run, even though growth may appear to start a few weeks earlier as a result of the burning. Kansas agronomists checked the effects of burning bluestem range over a long period of years with the following differences in yield of forage per acre.

Unburned plot	2,502 lb. per acre
Burned April 30	2,161 " " "
Burned April 10	1,934 " " "
Burned December 1	1,926 " " "
Burned March 20	1,845 " " "

Research in the coastal regions suggests that burning some types of grasses in those regions is beneficial.

Such pasture management practices as contouring, pitting of the sod, building of stock water ponds or tanks to help control grazing, use of drift fences, feeding supplements to prevent overgrazing in emergencies, rotation grazing to permit native grasses to set seed, rodent control, use of fireguards along highways, and many other more localized improved management practices make possible more productive permanent pastures. A discussion of all the peculiar problems of each range area would make too lengthy a discussion for this text.

Permanent pastures outside the range area also vary tremendously in quality, carrying capacity, and length of grazing season, but at least in this situation lack of rainfall is ordinarily not the big problem. Soil infertility, overgrazing, erosion, and competition from weeds, underbrush, and scrub timber are the big problems here. Correcting soil mineral element deficiencies according to needs demonstrated by soil tests is the first step in pasture renovation. Seeding of recommended mixtures of grasses and legumes according to proven procedures, followed by sound pasture management, makes possible carrying capacities as high as a cow and calf per acre for the pasture season in areas consisting largely of once-cultivated but now abandoned farm land. As mentioned earlier, brush control, by reducing competition for desirable grasses, can improve grazing in both range and non-range areas.

Gains Made by Cows on Pasture. The gains made by cows on pasture during the summer depend upon a number of factors, among which are the abundance and nutritive value of the forage, the condition of the cows when turned onto pasture, the age of the suckling calves, and whether or not the calves are creep fed. In most sections of the country the cows have calved before they are turned onto

pasture and have lost considerable weight from parturition and subsequent suckling. In much of the range country, weight loss occurs throughout the winter. These losses from all causes often amount to 150 to 200 pounds per cow. Half or more of these losses usually is regained during the first two months on pasture while the grass is fresh and abundant, and the remainder is regained during the fall and early winter after the calves are weaned. Frequently the cows lose in weight during the middle of the summer when the pastures are scorched and dry and the calves, now grown to good size, sap the strength of their mothers by their frequent nursing. One advantage of creep-feeding calves that run with their mothers on pasture is to relieve the cows of part of the burden that their offspring impose upon them during the latter half of the summer.

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Table 48

EFFECT OF SUPPLEMENTARY FEED UPON THE PASTURE AREA REQUIRED PER COW AND CALF*

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			Cottonseed Meal	Corn Silage	Cottonseed Meal	Corn Silage
			Lbs.	Lbs.	Lbs.	Lbs.
1.50	161	12	.52	18 6	.04	1.35
1.00	145	93	.35	14.0	.22	9.06
.50	161	153	.73	29.2	70	27.85

* Illinois Experiment Station; Average of three years' work.

Sudan grass, seeded alone or with soybeans, is an excellent pasture crop for late summer and early fall. Sudan grass should preferably be sown in ploughed and carefully prepared ground. Care should be exercised in grazing Sudan grass because of the danger from prussic acid poisoning. This poisoning is most apt to occur when abundant new growth follows a period of drought or when second-growth is grazed following earlier grazing or cutting for hay.

Shade and Water. Ordinarily too little attention is paid to providing adequate shade and sufficient fresh water for cattle during hot weather. Many pastures are entirely without shade of any kind and the cattle are exposed to the heat and glare of the sun throughout the long days of summer. Tall-growing species of trees make the best shade for permanent pastures but in rotation or temporary pastures portable shades are preferable. California workers in the Imperial Valley found that high shades are the most efficient.

The effect of shades, both natural and artificial, is well illustrated

Table 49

EFFECT OF TYPE OF SHADE ON TEMPERATURE UNDER SHADE AND PERFORMANCE OF CATTLE*

Comparison	1 Galvanized Iron Check Shade	2 Air-cooled by Desert Evaporative Cooler	3 Burlap Roof Cooled by Sprinklers	4 Galvanized Iron Cooled by Sprinklers
Temperature between 11 A.M. *and* 7 P.M., *August 6*				
Av. outside air temperature (°F.)	103.5	103.5	103 5	103 5
Air temperature under shade (°F.)	104 0	96 5	101.5	101 5
Temperature of underside of roof (°F.)	127.5	99.5	89 0	92.0
Ground temperature under shade (°F.)	107 5	95 3	97.2	100 0
Cattle Performance (55 days)				
No. of Hereford steers	5	5	6	5
Av. initial weight, lb.	430	428	429	420
Av. daily gain, lb †	0 69	1.05	0 80	0.89
Respiration rate on very hot, humid day	116	107	80	105

* Compiled from data in *Journal of Animal Science*, Vol. 184, p 10, 1951.

† Ration consisted of good alfalfa hay with 1 lb. barley per head added during the last 27 days.

has shown that about $1\frac{1}{2}$ to 2 acres of improved permanent pasture are required to carry a cow and calf from about May 1 to November 1. However, this area can be materially reduced if additional feed is supplied. Table 48 shows how the pasture area was reduced 33 and 66 per cent respectively at the Illinois station by the use of different amounts of supplementary feed.

One of the most satisfactory feeds with which to supplement pastures is corn, sorghum, or grass silage. Silage is palatable, succulent, and usually reasonably cheap. Seldom do cattle refuse to eat 15 to 20 pounds of silage per day, even though the supply of grass is abundant. On the other hand, dry hay or straw remains in the racks almost untouched as long as the supply of grass holds out.

Cowmen often make the mistake of delaying summer feeding too long. If it is to be a supplement to the grass and is to prolong the grazing period, feeding must be begun long before the grass is exhausted. The excuse so often heard—that the farmer hoped for a rain which would make feeding unnecessary—is not valid, since a closely cropped pasture seldom recovers as quickly after a rain as one that has had better treatment. It is much easier to discontinue feeding when it proves to be unnecessary than it is to repair damage to grass and cattle resulting from delaying feeding too long.

If no silage, hay, or green forage such as corn or sorghum for chopping are available, it may be necessary to feed some grain to the cows during the summer. Six to eight pounds of grain a day per cow is usually sufficient, or specially designed emergency range pellets may be fed in amounts recommended by reliable manufacturers.

Supplementary Pasture Crops. Since pastures frequently become brown and bare toward the end of the grazing season, the far-sighted cowman takes steps, if possible, to provide forage crops with which he may supplement his regular pastures should a shortage of feed develop. In all but the range area and the winter wheat belt, clovers seeded in early spring in small grain are excellent for this purpose. Red, sweet, and alsike clovers, seeded alone or in simple mixtures, are, except in unusually dry weather, ready for light pasturing soon after the grain in which they have grown has been harvested. Usually good grazing is furnished by such "stubble pastures" from about the middle of August until the latter part of September. Close grazing of spring-sown clover is inadvisable if it is to be used two seasons, because close grazing tends to weaken the young plants and make them very susceptible to winter-killing. As a rule clover pastures should be grazed with extreme caution after the first heavy frost, since frosted clover tends to cause both bloat and excessive scouring in cattle.

Sudan grass, seeded alone or with soybeans, is an excellent pasture crop for late summer and early fall. Sudan grass should preferably be sown in ploughed and carefully prepared ground. Care should be exercised in grazing Sudan grass because of the danger from prussic acid poisoning. This poisoning is most apt to occur when abundant new growth follows a period of drought or when second-growth is grazed following earlier grazing or cutting for hay.

Shade and Water. Ordinarily too little attention is paid to providing adequate shade and sufficient fresh water for cattle during hot weather. Many pastures are entirely without shade of any kind and the cattle are exposed to the heat and glare of the sun throughout the long days of summer. Tall-growing species of trees make the best shade for permanent pastures but in rotation or temporary pastures portable shades are preferable. California workers in the Imperial Valley found that high shades are the most efficient.

The effect of shades, both natural and artificial, is well illustrated

Table 49

EFFECT OF TYPE OF SHADE ON TEMPERATURE UNDER SHADE AND PERFORMANCE OF CATTLE*

Comparison	1 Galvanized Iron Check Shade	2 Air-cooled by Desert Evaporative Cooler	3 Burlap Roof Cooled by Sprinklers	4 Galvanized Iron Cooled by Sprinklers
Temperature between 11 A.M. and 7 P.M., August 6				
Av. outside air temperature (°F.)	103.5	103.5	103.5	103.5
Air temperature under shade (°F.)	104.0	96 5	101 5	101 5
Temperature of underside of roof (°F.)	127.5	99 5	89.0	92 0
Ground temperature under shade (°F.)	107.5	95 3	97.2	100 0
Cattle Performance (55 days)				
No. of Hereford steers	5	5	6	5
Av. initial weight, lb.	430	428	429	420
Av. daily gain, lb.†	0.69	1.05	0 80	0 89
Respiration rate on very hot, humid day	116	107	80	105

* Compiled from data in *Journal of Animal Science*, Vol. 184, p 10, 1951

† Ration consisted of good alfalfa hay with 1 lb barley per head added during the last 27 days.

by the Louisiana experiment summarized in Table 50. The artificial shades were not as high as those recommended by the California workers, being only 7 feet high. Roofs of the Louisiana shades were made from 6-inch-thick layers of hay, straw, or pasture clippings supported by wire netting. It should be noted that the breeds used in this study were Herefords and Angus which are not so well adapted to the hot, humid weather of the coastal region as is the Brahman breed or its crosses. Thus the favorable response to shades as reported here would not likely occur to the same extent if the latter breed or its crosses were used.

Water should be readily accessible to cows and calves in all pastures. Energy expended in walking great distances to water, or shade for that matter, is lost from a productive standpoint and thus should be kept to a minimum. Pasture areas which are over 2 or 3 miles from water will not be well utilized and, what may be still more serious, when water is not well distributed, overgrazing takes place near the watering places.

Farm and ranch ponds should be fenced, and a tank with float control should be situated below the dam for best results. Water is cleaner and cattle do not damage the dam and pond itself by wading into the water for cooling purposes.

Metal or wooden tanks, partially covered, are most suitable for temporary pastures. Shades or covers over the tanks lower the temperatures of tank water with the result that somewhat less water is consumed during very warm weather.

In an Illinois experiment, conducted during June and July, water in tanks provided with shades 7 feet high averaged 11° F. cooler during the day than the water in the unshaded tanks. Steers being full-fed corn on lush alfalfa pasture drank 9.4 per cent more water in the lot in which the tank was unshaded. On such lush pastures, which are high in water content, excess consumption of drinking water conceivably could reduce intake of dry matter. It has not been proved experimentally that water consumed by cattle must be clean for normal performance, but average precautions do not seem out of order.

Protection from Flies. Flies annually cause millions of dollars of loss to cattlemen. The hornfly is the principal species that annoys grazing cattle, and the stable fly is the more troublesome to animals confined in barns and feed lots during the summer months. Both species are bloodsuckers, and the loss of blood suffered by animals of all ages during a long period of heavy fly infestation constitutes a serious tax upon the herd. To this must be added the severe physical torture that the flies inflict, the large amount of energy expended by

Table 50

EFFECT OF TYPE OF SHADE ON PERFORMANCE AND GRAZING HABITS OF HEREFORD AND ANGUS COWS AND CALVES*

(Four-Year Summary, 1951–1954)

Treatment	*Abundant* Natural Shade		*Scanty* Natural Shade		*Artificial* Shade		*Without* Shade	
Class	Cows	Calves	Cows	Calves	Cows	Calves	Cows	Calves
Number	255	255	110	110	40	40	112	112
Av. weight, lb.	1,013	336	1,037	349	990	354	960	322
Av. daily gain, lb.	1.29‡	1.85‡	1 00†	1.64†	0.84	1.78†	−.05	1.18
Grazing habits (6 A.M.–7 P.M.)								
Grazing, hr. and min.	4:16	3:05	4:13	2:45	3:58	3:06	3:17	2:42
Standing, hr and min.	4:16‡	4:00‡	4:30‡	4:03‡	4:55†	3:49‡	6:04	5:06
Lying, hr and min.	4:28‡	5:55†	4:17‡	6:12‡	4:07†	6:05†	3:09	5:12
Av. maximum temperature, °F.	89.6	89.6	91.4	91.4	88.4	88.1	86.9	86.9
Av. relative humidity, %	63.1	63.1	62.4	62.4	62.8	62.8	64.0	64.0

* *Journal of Animal Science*, 15:59.

†, ‡ Values significantly different, 5 per cent and 1 per cent level, respectively, from those of the "without shade" treatment.

the cattle in trying to shake off their relentless enemies, and the small amount of grazing done by the harassed cattle in the daytime. Any one of these alone would reduce growth and fattening.

Fortunately cattle may be protected from both hornflies and stable flies by dipping or spraying the animals with an effective insecticide such as a solution of chlordane or DDT, as will be more fully discussed in Chapter 30. The first application should be made in the spring at the same time or soon after the cattle are turned onto pasture, and additional sprayings should be made during the summer at intervals of 4 to 6 weeks. Sheds, barns, and feeding equipment used by the cattle during the summer should also be sprayed with an effective fly-killing agent to destroy house and stable flies which breed in moist straw and manure around the farmstead or ranch headquarters.

Salt. Cattle on grass usually consume a somewhat larger quantity of salt than they do in the dry lot. Ordinary "Sunday morning" salting is not sufficient unless enough salt is given to last the entire week. The practice of keeping block salt constantly before the cattle is strongly recommended. A mature cow requires about 0.1 pound of block salt per day, or 18 pounds during a 6 months grazing season. About 20 pounds a head should be supplied since a small amount is dissolved by the rain.

Location of the salt in a pasture can be effectively used to insure more efficient range utilization. Successful ranchers often use salt to entice cattle into relatively inaccessible or isolated areas in mountain ranges which the cattle would otherwise be disinclined to frequent. In areas such as most of the southeastern and Gulf Coastal regions of the country, where mineral supplementation is recommended for cattle on pasture, loose salt is usually offered free-choice or in combination with minerals in weatherproof salt and mineral feeders.

Mineral Supplementation on Pasture. With the exception of salt, phosphorus is the mineral most apt to be deficient in summer pasture or range. This deficiency is much more apt to occur in areas where soils are deficient in phosphorus as previously indicated in Figure 31.

If cows are wintered on harvested forages of good quality, and especially if protein supplements such as soybean or cottonseed oil meals are fed, phosphorus-deficient or low phosphorus-content summer pasture or range is not so serious insofar as reproduction is concerned. On the other hand, if cows graze such mineral-deficient forage in summer and then are wintered on dry, cured forage of the same type, serious reductions in per cent calf crop weaned and in weights of all ages of cattle are bound to follow.

New Mexico Experiment Station workers compared the production

Table 51

EFFECTS OF MINERAL SUPPLEMENTS ON WEIGHT AND PRODUCTION OF RANGE CATTLE (RESULTS OF 7 YEARS)*

Measure of Production	Cows Not Fed Minerals	Cows Fed Minerals	Gain from Mineral Feeding
Cows calving, per cent	90.4	92.2	1.8
Calves died, per cent	10.8	2.7	8.1
Cows weaning calves, per cent	80.7	89.7	9.0
Average weight of calves,† lb.	408	442	34
Average production per cow, lb.	336	389	53
Gain of yearling steers, lb.	321	353	32
Gain of 2-year-old heifers, lb.	202	278	76

* New Mexico Agriculture Experiment Station Bulletin 359.
† Average weight of calves multiplied by per cent of cows weaning calves.

of two herds handled under similar conditions with the exception that one herd had year-round access to a mineral mixture composed of half salt and half steamed bonemeal (a common source of supplemental phosphorus in cattle rations). The pertinent data from their 7-year study are shown in Table 51. The annual consumption of mineral mix, including salt, was 51.7, 30.2, 34.5, and 73 pounds, respectively, for cows, calves over 7 months, yearlings, and bulls. Since half the mixture was salt, which was needed in any case, the consumption of 26 pounds steamed bonemeal, valued at less than $1 per cow annually, resulted in a 9 per cent larger calf crop weaned, and those calves weaned averaged 53 more pounds in weight. Improved performance for the other classes of stock was equally as striking. Texas workers got similar responses from adding the phosphorus to the drinking water in a soluble form. Supplementation with calcium alone (the other important constituent of bonemeal) on summer pasture has not produced similar results.

Not all cattle would respond similarly to phosphorus supplementation on pasture or range. Consultation with pasture specialists or animal nutritionists in the local area is recommended in this situation.

Breeding on Pasture. Cows that are to calve in the springtime must be bred during the early summer months. At this time they are, of course, on pasture, where their heat periods are likely to pass by unobserved. This is also the time of year when farmers and ranchers are very busy with field work or haying, so that the temptation to let a cow "go over" unbred is often strong. For these reasons it is

usually advisable to let the bull run in the pasture with the cows during the breeding season. It is, of course, to be understood that a bull so handled should be sound and mature. Also, the herd should be divided, if it is practical, so that there are not more than 25 or 30 cows with each bull.

Creep-Feeding Calves on Pasture. In the commercial cow-calf program the question of whether or not to creep-feed—that is, provide a grain ration to suckling calves in an enclosure accessible to the calves but not their mothers—depends upon the method of disposal or marketing of the calves. Not all experimental results agree on this subject, but in most instances creep-feeding does not pay if the weaned calves are sold as feeder calves. If, on the other hand, the calves are

Table 52

CREEP-FEEDING BEEF CALVES*

(166 DAYS)

	Lot 1 Not Creep-Fed	Lot 2 Creep-Fed	Lot 3 Creep-Fed (Molasses)
Average birth date, March	4	5	5
Number of calves	15	15	15
Steers	7	7	7
Heifers	8	8	8
Average feed per head (lb.)			
Corn		188	330
Oats		94	198
Cottonseed meal		31	66
Molasses			66
Average weight per calf (lb.)			
Initial 4/29/53	163	166	164
Final 10/12/53	451	483	521
Total gain (lb.)	291	317	357
Average daily gain (lb.)	1.75	1.91	2.15
Feed cost per head ($)		9.50	21.43
Financial ($)			
Appraised price per cwt.			
Slaughter	11.50	13.50	16.50
Feeder	16.00	16.50	16.50
Value per calf†			
Feeder	50.60	63.18	83.32
Feeder	70.40	77.22	83.32
Value per calf minus feed cost‡	70.40	67.72	61.89

Table 53

FINISHING STEER CALVES IN DRY-LOT AFTER CREEP-FEEDING*

	Lot 1 Not Creep-Fed	Lot 2 Creep-Fed	Lot 3 Creep-Fed (Molasses)
Number of days fed	117	89	75
Average weight per calf (lb.)			
Initial 10/13/53†	440	464	531
Final‡	687	635	665
Daily gain to selling	2.11	1.92	1.79
Average daily ration (lb.)			
Ground yellow corn	10.25	9.09	10.45
Cottonseed meal	1.50	1 50	1.50
Alfalfa hay	0 98	0.99	0.99
Prairie hay	2 50	2.72	2.17
Financial ($)			
Feed cost per cwt. gain	18.19	18.36	21.61
Initial cost§	77.00	83.52	95.58
Feed cost per steer	44.93	31.41	28 96
Selling price per cwt.	21.00	21.13	22.00
Total value per steer	144.27	134.18	146.30
Return per steer	22.35	19 25	21.76
Carcass grade			
Low prime	1		
High choice	3		4
Average choice	3	4	3
Low choice		3	
Average dressing percentage	60.1	5.89	59.0
Profit Summary, Both Phases ($)			
Value per steer when sold	144.27	134.18	146 30
Feed cost	44.93	40.91	50.39
Return (value of steer minus feed cost)	99 34	93.27	95.71

* Oklahoma Experiment Station Miscellaneous Publication MP-34.
† Weighed after an overnight shrink.
‡ Weights were shrunk 3 per cent.
§ Based on value as feeder steers at weaning time.

not of sufficient quality to sell well as feeders, but rather are sold to butchers as slaughter calves, creep-feeding results in a larger return. Table 52 illustrates how the ultimate objective of a particular cow-calf program determines whether creep-feeding is advisable. Note that, although the feeding of concentrates increased gains materially, the added value of the extra gain was not sufficient to pay for the feed, to say nothing of some extra labor and equipment costs.

After weaning, the steer calves in this test were placed on a drylot baby-beef fattening program and fed to approximately 650 pounds final weight. Admittedly this is a light selling weight, and the differences shown in Table 53 would undoubtedly have narrowed with a longer feeding period. However, the inadvisability of creep-feeding for anything but calves which are to be sold as slaughter calves is again illustrated. Time was saved, of course, because the creep-fed calves reached market weight sooner. Consequently some labor was also saved, but if the breeder also fed out his own calves, the labor saved during the fattening period would be offset by the extra labor required for creep-feeding in summer.

For those programs in which creep-feeding is to be recommended—the fat-calf and the purebred programs—recommendations as to which concentrate mixtures to use and where and what type of creep-feeder to build, will be made in Chapters 24 and 27.

Creep-fed calves may in many instances actually sell for less per hundredweight as feeders than the same quality of calves not creep-fed. Cattle feeders who desire to utilize fall pasture and stalk fields or who

FIG. 31. A well-located creep feeder in use in a purebred operation. (American Angus Association)

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FIG. 39. A well-located creep feeder [illegible] (American Angus Association.)

simply winter their calves on a roughage program do not feel that it pays to buy calves with extra condition and bloom since the calves usually lose it when handled according to this plan. The added weight the feeder has to buy may only result in lower gains while in the feed lot.

Dry Cows and Two-Year-Old Heifers. Dry cows which will calve in the fall and yearling or 2-year-old heifers which will not calve during the grazing season require comparatively little attention during the summer. Ordinarily the cows with calves are given the best pasture, whereas the dry she-stock is required to get along on somewhat less abundant forage. It is also a common practice to take the dry cows to that pasture farthest removed from the farmstead, inasmuch as they do not require the daily attention needed by the unbred cows and those with calves. Only in very dry weather or pronounced overstocking is feed other than grass necessary.

Summer Management without Pasture. Pasture is not absolutely necessary for the well-being of cattle in summer, as has been proved rather conclusively at the Illinois station where 10 heifers were kept in a small paved lot from the time they were weaned until they were 4½ years old. This period covered 4 summers, during the last 2 of which the cows were suckling spring-born calves. During the entire 4 years the cows received nothing except corn silage supplemented with cottonseed meal at the rate of 2½ pounds of cottonseed meal per 100 pounds of silage fed. The daily feed of silage for the mature cows was 40 pounds. These cows, kept constantly in the dry lot, maintained their weight nearly as well as other cows that were on pasture each summer, and they produced calves that were in every way normal The only trouble experienced during the summer was a few cases of foot rot among the calves.

In a recent Iowa experiment, cows nursing calves consumed daily 114 pounds of an alfalfa-grass mixture, fed as green chop. These green-chop-fed cows gained an average of 7 pounds for the summer period as compared with a loss of 70 pounds for comparable wet cows on a permanent pasture. Weaned calf weights were 370 and 405 pounds respectively for the calves nursing the permanent-pasture and green-chop cow groups. However, because of the added charge made for the labor of harvesting and feeding the green chop, the heavier calves returned a smaller margin of profit per calf.[1]

These experiments, together with the knowledge we have concerning the wide use made of soiling crops—that is, harvesting and feeding forage crops in a fresh state—in Europe, prove conclusively that

[1] Iowa State College AH Leaflet 230, 1958

FIG. 40. A purebred Polled Hereford bull being used to dehorn calves through heredity. If the bull is homozygous for the polled character the horned cows will produce only polled calves. (American Hereford Association)

with a strong chemical. This method is best used when the calf is 1 to 5 days old. The agent most commonly used is caustic potash (potassium hydroxide), although caustic soda (sodium hydroxide) is equally effective. Either of these chemicals may be purchased in the form of pastes, liquids, or slender sticks which are about the size and appearance of blackboard crayons. Care should be exercised in using caustics because they cause serious burns if they come in contact with the hands of the operator.

In removing horns with caustic one should proceed somewhat as follows: With a pair of hand clippers or ordinary scissors, clip away the hair as closely as possible immediately over the budding horn, so that its outline is clearly exposed. Next, *slightly* moisten one end of a stick of caustic by dipping just the exposed tip in water (not touching to the lips or tongue), and rub it lightly with a rotary motion on

pastures are not indispensable in raising beef cattle. However, the great amount of labor involved in caring for cattle under such conditions precludes any wide use of such methods in this country at the present time, unless automatic feeding systems, silo unloaders and auger bunks for feeding silage, or field choppers and self-feeding bunk wagons for soiling or feeding green chop are installed and used year-round. Drylot summertime rations for cows nursing calves should be compounded according to the requirements shown in Chapter 10 for nursing cows.

Because most calves are "worked"—that is, dehorned, castrated, marked, and vaccinated during summer and weaned in the fall, brief discussions of these jobs are appropriate in connection with summer management of the cow herd. This discussion is not to imply, however, that such chores can only be done then.

Dehorning. Although a nicely shaped pair of horns undoubtedly adds to the appearance of an animal of the horned breeds in the show ring or purebred herd, the presence of horns on commercial cattle is considered objectionable. Horns are the cause of so much loss to the large slaughtering establishments in damaged hides and bruised carcasses that polled or dehorned cattle normally sell from $1 to $2 per hundredweight higher than horned cattle of equal merit in other respects. This statement is particularly true when the animals have been shipped some distance and have been in crowded cars or trucks for several hours. Horns are also objectionable on the farm and in the feed lot. Cattle with horns require more shed room per animal as well as more space at the feed bunk or hay rack and in the truck or car when shipped. Among horned cattle there is always a tendency for some to be "bossy" and to keep the timid ones away from their share of shelter and feed. Dehorning tends to curb the aggressiveness of such animals, thus lessening feedlot disturbances of this sort.

Dehorning by Breeding. The use of a polled bull results in a majority of hornless calves. If such a bull is a "pure" polled, carrying in his germ plasm no factor for producing horns, all his calves will be polled, even though all their dams have horns. If, however, the bull is an impure polled (the product, let us say, of a pure polled bull and a horned cow), only half his calves from horned cows will in the long run be polled, and the rest will have horns. Thus we see why it is that Angus bulls (which are almost invariably "pure" polled) seldom sire any but polled calves, whereas some polled bulls of the other two important beef breeds often beget a number of horned offspring.

Dehorning by Use of Chemicals. A satisfactory way to prevent the growth of horns in new-born calves is to burn the embryo horn

FIG. 40. A purebred Polled Hereford bull being used to dehorn calves through heredity. If the bull is homozygous for the polled character the horned cows will produce only polled calves. (American Hereford Association.)

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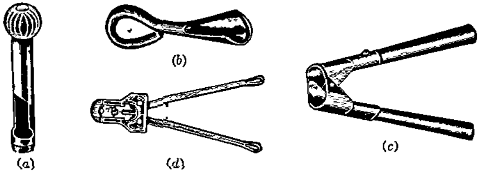
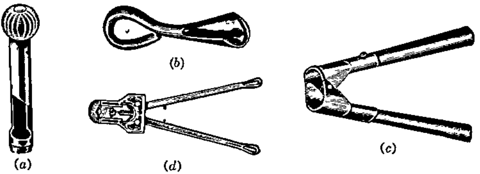


FIG. 41. Dehorning tools, listed in the order of age of calves for which they are best suited: (*a*) dehorning tube, 1 to 3 months; (*b*) dehorning spoon, 3 to 5 months; (*c*) Barnes dehorners (available in two sizes), 5 to 12 months; (*d*) Leavitt clippers, 12 to 24 months; (*e*) dehorning saw (not shown), over 24 months. (O. M. Franklin Serum Company, Denver, Colorado.)

less, and their horns are severed much more easily and quickly. Either a dehorning saw or some type of dehorning clippers is used in dehorning cattle more than 4 months of age (see Fig. 41, *c* and *d*).

Equipment for Dehorning. For dehorning calves, not much equipment is necessary. Often they are simply thrown to the ground and held firmly, or sometimes they are snubbed to a fence post. However,

FIG. 42. The entire family often helps at calf-working time on the range. Corrals with headgates, and sometimes tilting tables, are used on many ranches where less labor is available (American Hereford Association)



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each horn button. If the paste or liquid form is used, a thin coating of caustic should be applied with the applicator to each horn area. Care should be taken not to apply too much, since it may spread to the skin surrounding the horn and cause serious burns. Inexperienced operators should guard against such an accident by applying a thin coating of vaseline or lard to the surrounding skin, leaving only the horn button exposed.

The effect of the caustic is to deaden the matrix or root of the horn. In a few days a scab appears over each horn button; this soon drops off, leaving a smooth spot of skin devoid of hair, no larger than a dime. Even these spots are soon hidden by the growth of the adjacent hair, so that no trace of the operation is apparent.

Since use of caustic, to be successful, should be made while the calf is very young, this method of dehorning requires considerable labor if the calves are born on pasture. Consequently we find caustic employed mainly on farms where the calves can be caught and treated with little trouble and labor.

The Electrical Dehorner. An electrically heated dehorning iron is sometimes used instead of a chemical for dehorning young calves on farms where electricity is available. After the iron has been heated to the proper temperature it is fitted over the horn button and held firmly against the head until the matrix has been destroyed. Considerable care must be exercised to make the burn deep enough to destroy the horn tissue but not so deep as to produce a bad sore. The operation is much more painful and requires more time than chemicals. However, it may be used to dehorn calves up to 2 months of age.

Dehorning Older Calves. In large herds of commercial cattle, especially in the range area where the cows and calves are widely dispersed, dehorning is usually postponed until the calving season is nearly over, in order that all calves may be dehorned, castrated, and branded with only one working of the herd. At this time the horn buttons of most of the calves are well developed but are still so soft and loosely attached to the skin that they may be easily removed with a knife-like dehorning tool which separates the horn button from the adjoining skin with little or no loss of blood. Such tools are called "gougers," "spoons," and "tubes," depending upon their shape and the way in which they are used (see Fig. 41, *a* and *b*).

Calves that are not dehorned under 3 months of age usually are allowed to retain their horns until late in the fall after they are weaned or until the following spring when they are approaching 1 year of age. The younger the animal when dehorned the better, since the horns are softer and can be removed with less shock than is suffered by older animals. Moreover, the labor required to restrain young animals is

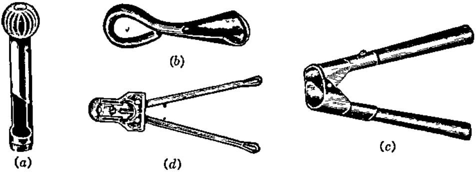


FIG. 41. Dehorning tools, listed in the order of age of calves for which they are best suited: (*a*) dehorning tube, 1 to 3 months; (*b*) dehorning spoon, 3 to 5 months; (*c*) Barnes dehorners (available in two sizes), 5 to 12 months; (*d*) Leavitt clippers, 12 to 24 months; (*e*) dehorning saw (not shown), over 24 months. (O. M. Franklin Serum Company, Denver, Colorado.)

less, and their horns are severed much more easily and quickly. Either a dehorning saw or some type of dehorning clippers is used in dehorning cattle more than 4 months of age (see Fig. 41, *c* and *d*).

Equipment for Dehorning. For dehorning calves, not much equipment is necessary. Often they are simply thrown to the ground and held firmly, or sometimes they are snubbed to a fence post. However,

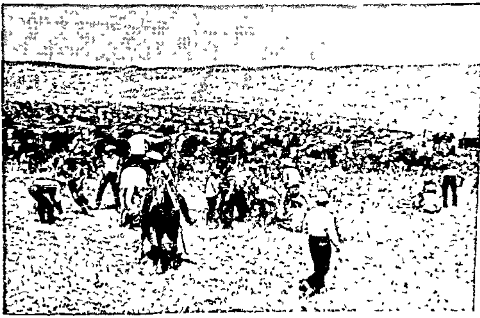


FIG. 42. The entire family often helps at calf-working time on the range. Corrals with headgates, and sometimes tilting tables, are used on many ranches where less labor is available. (American Hereford Association.)

if many calves are to be dehorned it is highly advisable to construct a regular dehorning chute such as is recommended for older cattle in the following paragraph or, if herds are large and calves will be worked in accessible areas, special tilting tables are justified.

For yearlings and older cattle, some special means of restraint is necessary, especially if the number of animals to be dehorned is large. Various types of dehorning chutes, pinch gates, squeeze chutes, and cattle stocks have been devised, all of which are designed to secure the animal while an operation is being performed. Some of them are more suited for dehorning than others because of the rapidity with which cattle may be driven in and let out—a highly desirable feature when a large number of animals must be worked.

Sawing vs. Clipping. In former years the saw was almost universally used in dehorning older cattle. Lately, however, it has been largely superseded by various forms of shears or clippers. The principal advantages of the saw are as follows:

1. There is no danger of crushing the horn as is sometimes done with clippers.

2. The action of the saw blade produces a lacerating of the blood vessels rather than a clean-cut cross section. The danger of excessive bleeding is thus minimized.

3. There is more likelihood of the cut's being made at just the right place

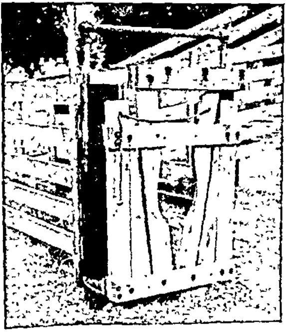


FIG. 43. Close-up view of headgate. The chute or alley leading to the headgate should be only 24 inches wide to prevent small calves from turning around. (Livestock Conservation, Inc., Chicago, Illinois.)

body—in particular, a better balance between front and hindquarters. It is generally believed that castration improves the texture, tenderness, and flavor of beef but recent tests with bull carcasses do not bear out this belief. However, steers are much quieter in the feed lot than bulls. This fact alone would justify castration.

Age and Reason for Castration. Castration is best done when calves are 4 to 10 weeks old. Many writers on the subject recommend that the operation be performed when the calf is only a few days old, claiming that less pain and loss of blood result than if it is done later. Although such claims are undoubtedly true, the testicles of very young calves are so small and soft that it is often difficult to distinguish them from the surrounding tissues. Also, it occasionally happens that the testicles do not descend into the scrotum until several days after birth. The castration of older animals is, of course, attended with more risk, but seldom do any serious complications develop. As a matter of fact, during the early part of the twentieth century scores of yearling range bulls were successfully castrated every fall at the big central markets after their sale to Corn Belt cattle feeders. If not too thick and heavy in the front quarters, they often sold on a par with ordinary steers when finished and returned to market. Bulls over 2 years of age or older are seldom castrated but are fattened and sold entire because, if castrated, they have to sell as stags.

Like dehorning, castration should be performed when weather conditions are the most favorable. The spring and fall months are considered the best, although winter castration is not objectionable if it is done on a mild, bright day and if adequate protection is furnished the following night. As a rule, calves born during the winter and early spring are castrated just before being turned to pasture, whereas those born during the summer and fall are allowed to go until they are brought in from the pasture in the fall. On the range, castration is performed at the summer and fall round-ups.

Methods of Castration. Young calves are usually thrown to be castrated, but animals over 4 months of age may be operated on better while they are standing. In throwing, the calf is placed on its left side and the feet held or "hog tied." This position leaves the scrotum exposed to the operator, who stands or kneels alongside the calf's rump. The scrotum should first be scrubbed with a sponge or piece of absorbent cotton saturated with a mild antiseptic, to remove any dirt that might otherwise get into the wound. The hands of the operator and the knife should, of course, always be washed in mild antiseptic solution.

Several satisfactory methods of surgically removing the testicles are used. Some of the more common methods are:

1. Removal of the lower one-third of the scrotum, exposing both testicles. In calves 3 months of age or less, the testicles can then easily be removed by working each testicle loose and simply pulling it from the scrotum. In older calves where bleeding may be more severe, the testicle should be worked loose, then the cord should be severed as high into the scrotum or as near the body as possible. This may be done either by scraping with a knife blade until the cord comes apart or by crushing the cord with an emasculatome or clamp.
2. A sharp-pointed knife may be inserted into the side of the scrotum all the way through to the opposite side. Then with one downward stroke the scrotum can be split to the bottom, exposing the testicles for removal as described above.
3. Incisions can be made on each side of the scrotum from the middle to the lower end permitting a ready grasp of the testicle, which can then be removed as above. Show steers are usually castrated in this manner to insure a full, well-shaped cod.

Larger calves and bulls can be castrated standing if well secured. Pulling the tail sharply upwards and holding it firmly prevents the animal from kicking and injuring the operator. Any of the three methods described above can then be used for removing the testicles All three methods insure good drainage, which is perhaps the most important factor in castration. Removing as much cord as possible with the testicle insures that stagginess will not develop.

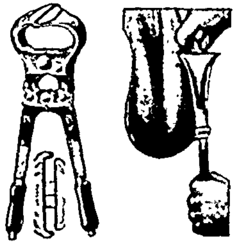
Treatment After Castration. After the testicles are removed the scrotum should be examined to make sure that the incisions are sufficiently large and low to afford proper drainage. The calves should be put in a clean box stall, if available, for a few hours until all danger of excessive bleeding is past. They may then be turned into a clean pasture or lot if the weather permits. Care should be taken that they have a clean place to lie. For this reason they should not be permitted access to lots covered with mud or manure, or to sheds that have not recently been cleaned and rebedded. Daily examinations should be made for a week or ten days to make sure that any swelling due to faulty drainage is promptly relieved by reopening the incision and irrigating the scrotum with an antiseptic solution. If castration is done in fly season, repellents should by all means be used.

Castration Pincers. Several years ago there was introduced into this country from Italy a unique kind of castration pincers called the

"Burdizzo." These pincers and others of similar type manufactured in this country have blunt jaws which close with enormous force when sufficient pressure is exerted on the handles to lock them into the closed position. In using the pincers the object is to crush or sever the spermatic cord and the blood vessels that supply the testicle so that the testicle degenerates for want of circulation.

The advantages of the Burdizzo over the knife are that there is no loss of blood and the skin is not broken to permit flies to deposit the eggs from which the dreaded screwworms develop. Nevertheless, the jaws of the pincers cut deeply into the skin and there is some danger that the scrotum itself may slough off for want of blood supply. This, however, may be prevented by severing each cord separately, one a little higher than the other, so that some of the blood vessels leading to the lower part of the scrotum escape injury. When such care is exercised an unusually attractive, well-shaped cod is acquired in the feed lot by animals that have been castrated with Burdizzo pincers.

At first very favorable results were reported from the use of the Burdizzo and it appeared that this method of castration would eventually supersede the knife, especially in Texas and adjoining states where the presence of blow flies and screwworms makes castration with a knife unsafe after March 1. However, it soon became evident that use of the pincers under practical conditions did not always sever the cord and blood vessels sufficiently well to arrest the development of the testicle. The result was a calf called a "slip," which would begin to show signs of stagginess when about a year old. When used under unfavorable conditions or by inexperienced operators the percentage



(a) (b)

FIG. 44. (a) Burdizzo castration pincers; (b) correct method of using to insure crushing of spermatic cord (O. M. Franklin Serum Company, Denver, Colorado.)

of slips would sometimes amount to 10 or 15 per cent. Slips are less frequent when calves are castrated by an improved type of Burdizzo that holds the cord in place when the jaws are closed (see Fig. 44 *a*).

More recently a new type of castration instrument called the *elastrator* has been used with some success in castrating calves. It is a pincer-like instrument which is used to slip a strong elastic band around the scrotum close to its attachment to the groin. The pressure exerted by the rubber band shuts off the blood supply to the scrotum and testicles, causing them to slough off, leaving no more loose skin between the hind legs than is usually seen in a heifer. Some cattle feeders object to steers that have been thus castrated because, with no cods, they appear light and shallow in the twist.

Marking. It is highly desirable that all animals in the herd bear some mark or tag whereby each can be positively identified. On the Western Range marking or branding is necessary to establish ownership. In all herds it is desirable to establish ancestry or pedigree, and it is a necessity if performance-testing is practiced.

The means employed for marking depends upon the object for which it is done. When the object in view is to establish ownership, as it is on the range and in poorly fenced pastures, ease of recognition is of paramount importance. Under such conditions branding with a hot iron is probably the best method. Although much has been said against branding because of the pain inflicted and the damage done to the hide, no good substitute for the iron has yet been devised. However, a brand should be no larger than is necessary to permit easy identification at a distance of 30 or 40 feet, and no deeper than is needed to destroy the hair follicles.

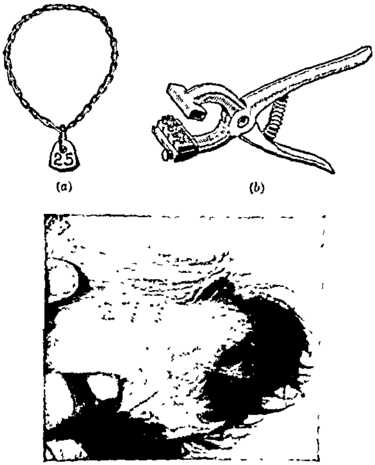
Other forms of ownership marks sometimes employed are ear "notching," "slitting," and "grubbing." The principal objection to such marks is that they detract greatly from the appearance of the animals. Another mark of this sort is the slitting of the dewlap in such a way that one or two "wattles" of skin hang down from the throat. This method is a rather common way of marking cattle in certain grazing sections in the West.

To establish the identity of each individual animal in the herd, numbered neck straps and chains, ear notches, ear tags, horn brands, and tattoos are all employed. The principal objection to neck chains is that they are frequently lost. If they are adjusted properly when the cattle are turned onto pasture in the spring, they become either too tight or too loose later on in the summer as the cattle gain or lose flesh. It is particularly difficult to keep the neck chains of growing calves and yearlings properly adjusted.

Although it is possible to adopt a system of ear notching that permits each animal to have its own "ear number," such a practice is seldom followed because ears so mutilated are very unattractive. Moreover, the notches are difficult to see even at short distances because they often are obscured by the hair.

Many forms of ear labels are on the market and may be purchased by the stockman for a small sum. As a rule they are easy to attach but usually are also easily lost and remain in place only a short time. Probably the round aluminum "ear button" is the best label of this sort because it is least likely to be torn out.

Horn branding is an excellent means of numbering mature horned cattle but is, of course, useless with calves and yearlings. Obviously



(c)

FIG. 45. Devices for marking cattle: (a) adjustable neck chain; (b) tattoo machine. A correctly tattooed ear (c). (O. M. Franklin Serum Company, Denver, Colorado.)

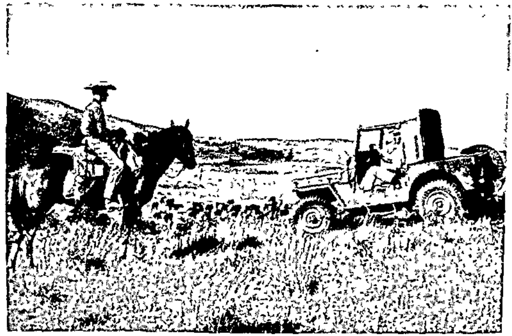


FIG. 46. Jeeps are replacing the cow horse on ranches which are level enough to permit their use Much of the western range is so rough in terrain, however, that horses will never entirely disappear from use. (*American Hereford Association.*)

to nurse until midsummer since green pasture causes cows to increase greatly their production of milk if they are still being suckled when they are changed from dry lot to pasture.

Calves that have been running with their dams should be removed from them once and for all. If they can be placed beyond even the sound of the cows, so much the better. The practice of turning them back on the second or third day to suck out the cows cannot be recommended because it tends to prolong the period during which they pine for their mothers and may give rise to digestive disorders caused by the stale milk. After weaning, the udders of the cows should be examined every few days to make sure that those showing signs of inflammation are given prompt attention. Cows that are to be dried up should not be milked dry but only enough milk should be withdrawn to relieve any undue congestion.

chapter **10**

THE WINTER MANAGEMENT OF THE BREEDING HERD

Economy should be the principal idea in planning for the winter management of the breeding herd. Economy does not imply a niggardly, stingy attitude on the part of the owner in supplying feed and shelter. What it does mean is that the expense of wintering should be no greater than the minimum necessary to insure the cattle a reasonable degree of comfort and to keep them vigorous and healthy. The production of beef calves is often conducted on a narrow margin of profit. At no point in the enterprise is a possible profit so likely to disappear and be replaced by a loss as during the wintering operations. Consequently it behooves the cattleman to spend some time in thoughtfully planning the best method of carrying the breeding herd through the winter months.

It is obvious that the management of the breeding herd during any period of the year depends to a great extent on whether the cows are suckling calves or are dry. In a herd of purebred cattle both spring and fall calves usually are produced, so that there are both milking and dry cows on hand at all times. The same may be said for the fat-calf program. The strictly commercial cow and calf man, on the other hand, usually has all his cows freshen at about the same time, which simplifies the wintering job tremendously.

A much more efficient job of winter management can be done, with respect to both feed and equipment costs, if the herd is sorted into age groups which are uniform in their feed and shelter requirements. Otherwise some cattle are always being either overfed or underfed. The five groups in a typical cow-calf operation which have nutrient requirements that differ enough to warrant sorting them for separate feeding are: dry cows, wet or nursing cows with their calves, heifer calves, yearling heifers, and bulls. The question of the winter management of yearling and 2-year-old heifers depends upon whether they are bred to drop their first calves as 2- or as 3-year-olds. If yearlings are bred to calve as two's, they can either be fed separately from the

dry cows or, perhaps better, fed along with the heifer calves, since both need rations containing some concentrates. On the other hand, if heifers are not bred until they are two's, to calve first as three's, then both the open yearlings and the bred two's can be grouped with the dry cows. In either case, heifer calves should be fed separately from the cows. Bulls, of course, should be removed from the herd during the winter if spring calving is practiced. Feeding them separately presents no serious management problem, although separate shelter is needed.

If the steer calves and heifers not needed for replacement are not sold at weaning time but are carried through the winter for selling either in the spring or as yearlings after grazing the following summer, they should be fed separately from the herd. Replacement heifers might in this case not be selected until late in the winter or in early spring in order that all calves might be handled together.

If the herd is of average size or larger, it is better to keep the dry cows separate from those that are suckling calves. Since dry cows require less feed and shelter they can be handled more economically than the rest of the herd. In a small herd, numbering perhaps less than 20 head, it seldom proves practicable to separate the females of breeding age during the winter. Any advantage that might be gained by such a practice would in all likelihood be overcome by the extra labor involved.

Buildings and Equipment. One of the advantages claimed for the beef cow by her ardent supporters is that she requires a small outlay for shelter and equipment. Expensive barns are by no means necessary. In fact, in some instances they may be a positive disadvantage. From a financial standpoint an investment of much over $100 per cow in buildings and equipment is an unrealistic financial outlay for a herd of beef cows kept solely to raise calves for the open market. The situation is, of course, quite different with high-priced registered cattle. Even here the elaborate barns and paddocks so often seen in connection with large purebred establishments are by no means indispensable. Large barns often have been erected at great cost, only to be discarded later for inexpensive open sheds in which the cattle seem to do better.

Dry cows prefer to live entirely in the open if the ground is sufficiently well drained to afford them a reasonably dry area on which to lie and if it is protected from high winds by hills or trees. Such a place is provided by rolling pastures which have some sheltered valleys protected by surrounding hills and thick stands of timber. Here the cows spend the entire winter in apparent comfort, even in

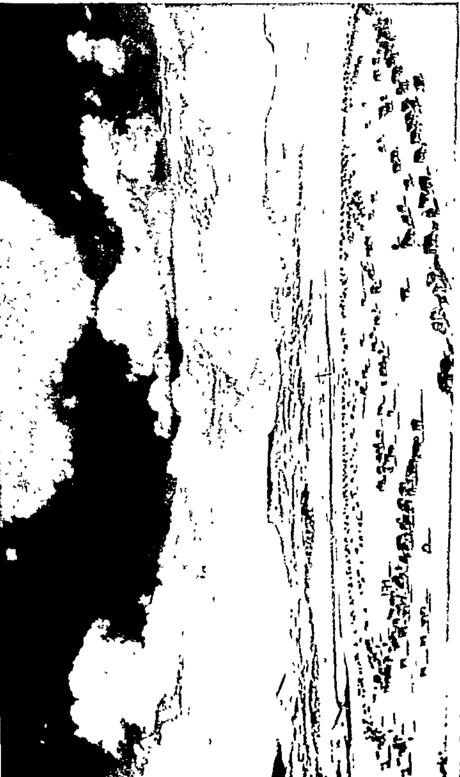


FIG. 47. Cows being wintered in northern New Mexico with only the shelter provided by the small mountains and draws. Often a high-energy mineral-vitamin fortified pelleted supplement is fed in these areas as insurance against deficiencies. (National Cottonseed Products Association, Inc.)

amount of flesh at the time of calving as they did at the beginning of winter. Cows that are very thin in the fall should be fed sufficiently well to gain from 100 to 150 pounds during the winter or enough to offset the loss they will sustain during calving. On the other hand, fleshy cows may have their ration restricted to the point at which they show no gain at all or show even a small loss in weight up to the date of calving. Experiments at the Montana station, partly summarized in Table 54, emphasize that cows should be in sufficiently good flesh and thrift at the time of calving to permit them to nourish their calves properly. For cows in fair condition at the beginning of winter an approximate total gain of either 65 or 25 pounds a head appeared to be more satisfactory than 110 pounds, from the standpoint of both the cow herself and her calf at either birth or weaning time. On the other hand, cows which lost about one-half pound per day

Table 54

EFFECT OF WINTER GAINS OF COWS UPON WEIGHTS OF CALVES*

High, Medium, and Low Winter Gains

	Number of Cows	Av. Winter Gain (lb.)	Calves at Weaning Av. Weight (lb.)	Calves at Weaning Av. Age (days)
8 high winter-gaining lots	62	110.4	384.4	161.0
8 medium winter-gaining lots	50	66.9	370.2	162.3
8 low winter-gaining lots	61	21.2	362.4	160.1

Winter Gains vs. Winter Losses of Cows

	Cows: Av. Winter Gain (lb.)	Cows: Av. Wt. at End of Winter (lb.)	Cows: Av. Wt. After Calving (lb.)	Calves: Av. Birth Weight (lb.)	Calves: Av. Weaning Weight (lb.)	Calves: Av. Age at Weaning (days)
11 highest winter-gaining cows	42.6	1,064.4	841.2	65.6	379.1	170.7
11 lowest winter-gaining cows	−62.7	981.3	781.3	64.6	326.9	177.1

* Montana Special Circular 7, "Animal Husbandry."

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11 lowest winter-gaining cows	−62 7	981.3	781.3	64 6	326 0	177.1

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near-zero weather. However, few farms have such sheltered areas sufficiently near the feed supply to permit feeding the cattle without considerable labor. Moreover, the manure produced by the cattle wintered in this way is largely lost. Consequently the breeding herd usually is wintered at or near the farmstead or ranch headquarters where it may be fed with a minimum of labor and where much of the manure may be saved and returned to the cultivated fields.

A deep shed opening to the south offers ideal sheltering conditions for dry cows. Here the cows may run together in groups of 10 to 50 head each or even larger. Thus handled they can be fed with a minimum of labor. Cows that are approaching parturition and those with very young calves should be handled apart from the rest of the herd if shed space is limited. However, after the calves are 10 days old, both cow and calf may be returned to the main herd. In a small herd the calves may sometimes be kept apart from the cows and allowed to nurse twice daily if a trap or pen is provided at one end of the shed, in which a deep, dry bed is available for the calves.

The lots occupied by the cattle need not be large. If possible it is best to have two lots—a small paved lot adjoining the shed, affording about 50 or 60 square feet of space per cow, and a much larger lot or paddock into which the cattle may be turned for exercise when the ground is dry or frozen. If pasture land or stalk fields are accessible the larger lot is unnecessary. The small paved lot, however, is almost indispensable in the non-range areas during the spring when the ground is soft and muddy. Pavement is much more desirable in the lot just outside the shed than under the shed itself. This combination keeps the cattle more comfortable and lessens the labor of feeding, and usually repays its cost many times over in the extra amount of manure saved.

Nutrients Required in Wintering Rations of Breeding Beef Cattle. The level of most nutrients required by breeding cattle in winter time, and especially energy, is determined by the condition or fleshiness of the cows and heifers at the beginning of the winter feeding period. Likewise the amount of gain a cow should make during the winter depends upon her condition at the beginning of the winter period. Pregnant cows in ordinary flesh should gain at least as much as is represented by the increased weight of the fetus, membranes, and fluids with the advance of gestation. This may be estimated at approximately 60 pounds from the fifth to the ninth month of pregnancy. Consequently spring-calving cows should gain at the rate of approximately one-half pound a day if they are to carry the same

amount of flesh at the time of calving as they did at the beginning of winter. Cows that are very thin in the fall should be fed sufficiently well to gain from 100 to 150 pounds during the winter or enough to offset the loss they will sustain during calving. On the other hand, fleshy cows may have their ration restricted to the point at which they show no gain at all or show even a small loss in weight up to the date of calving. Experiments at the Montana station, partly summarized in Table 54, emphasize that cows should be in sufficiently good flesh and thrift at the time of calving to permit them to nourish their calves properly. For cows in fair condition at the beginning of winter an approximate total gain of either 65 or 25 pounds a head appeared to be more satisfactory than 110 pounds, from the standpoint of both the cow herself and her calf at either birth or weaning time. On the other hand, cows which lost about one-half pound per day

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11 highest winter-gaining cows	42.6	1,064.4	844 2	65.6	370 1	170 7
11 lowest winter-gaining cows	−62.7	981.3	781 3	64 6	326.9	177.1

* Montana Special Circular 7, "Animal Husbandry"

weaned calves which were approximately 50 pounds lighter than those weaned by cows which gained about one-third pound daily.

Cows of approximately the same size voluntarily consume about the same amount of total feed regardless of condition. However, because cows of the same body size weigh less or more depending on whether the cows are thin or fleshy, it is necessary to use different factors for determining feed capacity for cows of varying condition. Cows that are thin, average, or fleshy with respect to condition consume daily (on an air-dry basis) an amount of feed that is equivalent to approximately 1.75, 2.00, and 2.25 per cent of their live weight, respectively.

The nutrient requirements for breeding beef cattle, as recommended by the National Research Council, expressed on the basis of daily needs and on the basis of percentage in the ration, are shown in Tables 55 and 56 respectively. Morrison's feeding standards for breeding beef cattle are shown in Table 57. Rations which meet the needs of the various weight and age groups of breeding cattle, according to the requirements or standards indicated, can be computed exactly from information concerning the composition of feeds as found in the Appendix Tables

Winter Rations for the Breeding Herd. The winter ration of beef cows should consist largely of the common farm roughages. Indeed, it is usually possible to maintain dry cows satisfactorily during the winter on roughages alone. Bred yearling heifers, underdeveloped bred 2-year-olds, and yearling bulls should receive, in addition to a full feed of roughage, from 2 to 4 pounds of grain or concentrates in order to balance their nutrient needs for energy. The supplemental protein needs of breeding females not nursing calves can be met by feeding ½ to 1½ pounds per day of a high-level protein concentrate such as the oilseed meals, or 2 to 6 pounds of legume hay or its equivalent. The remainder of the protein needed is supplied by the roughages fed, except in the case of wet cows or when such very low-protein-content roughages as ground corn cobs, stover silage, or stalk fields are fed. In these instances up to 2 pounds of the aforementioned protein concentrate or its equivalent in legume roughage is required.

The following roughage groups are commonly used in wintering breeding cows:

LEGUME HAYS. No better feed than clover or alfalfa hay could be recommended for breeding cows. However, an exclusive ration of legume hay would be unduly expensive, and for animals in average condition would supply more food nutrients than are actually needed. If enough legume hay is fed to furnish 20 to 30 per cent of the total

Table 55

DAILY NUTRIENT REQUIREMENTS OF BREEDING BEEF CATTLE*
(Based Upon Air-Dry Feed Containing 90 Per Cent Dry Matter)

Body Weight (lb.)	Av Daily Gain (lb.)	Daily Feed per Animal (lb.)	Daily Requirement per Animal: Total Protein (lb.)	Digestible Protein (lb.)	Total Digest. Nutrients (lb.)	Digestible Energy (therms)	Calcium (gm.)	Phosphorus (gm.)	Carotene (mg.)	Vitamin A, I.U.×1000
Wintering Pregnant Heifers										
700	1.5	20	1.5	0.9	10.0	20	15	14	28	11.2
900	0.8	18	1.4	0.8	9.0	18	13	12	36	14.4
1,000	0.5	18	1.4	0.8	9.0	18	13	12	40	16.0
Wintering Mature Pregnant Cows										
800	1.5	22	1.6	1.0	11.0	22	16	15	32	12.8
1,000	0.4	18	1.4	0.8	9.0	18	13	12	40	16.0
1,200	0.0	18	1.4	0.8	9.0	18	13	12	48	19.2
Cows Nursing Calves, First 3–4 Months Postpartum										
900-1,100	0.0	28	2.3	1.4	16.8	31	30	23	100	40.0
Bulls, Growth and Maintenance (Moderate Activity)										
600	2.3	16	2.0	1.2	10.1	20	21	15	35	14.4
1,000	1.6	20	2.4	1.4	12.0	24	19	15	60	24.0
1,100	1.0	21	2.4	1.4	14.2	28	17	16	84	33.6
1,800	0.0	26	2.4	1.5	14.0	28	15	18	108	43.2

* *Nutrient Requirements of Beef Cattle*, Sub-Committee on Beef Cattle Nutrition, National Research Council, revised edition, 1958.

Table 56

Nutrient Requirements of Breeding Beef Cattle Expressed as Percentage Composition of Air-Dry Rations*

Body Weight (lb.)	Av. Daily Gain (lb.)	Daily Feed per Animal (lb.)	Requirement as Per Cent of Ration or Amount per Pound of Feed: Total Protein (%)	Digestible Protein (%)	Total Digest Nutrients (%)	Digest. Energy (therms per lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg./lb.)	Vitamin A (I.U. per lb.)
Wintering Pregnant Heifers										
700	1.5	20	7.5	4.5	50	1.00	0.16	0.15	1.4	560
900	0.8	18	7.5	4.5	50	1.00	0.16	0.15	2.0	800
1,000	0.5	18	7.5	4.5	50	1.00	0.16	0.15	2.2	880
Wintering Mature Pregnant Cows										
800	1.5	22	7.5	4.5	50	1.00	0.16	0.15	1.5	600
1,000	0.4	18	7.5	4.5	50	1.00	0.16	0.15	2.2	880
1,200	0.0	18	7.5	4.5	50	1.00	0.16	0.15	2.6	1,040
Cows Nursing Calves, First 3–4 Months Postpartum										
900–1,100	0.0	28	8.3	5.0	60	1.20	0.24	0.18	3.6	1,440
Bulls, Growth and Maintenance (Moderate Activity)										
600	2.3	16	12.5	7.5	63	1.26	0.29	0.21	2.2	880
1,000	1.6	20	12.0	7.2	60	1.20	0.21	0.17	3.0	1,200
1,400	1.0	24	10.0	6.0	59	1.18	0.16	0.15	3.5	1,400
1,800	0.0	26	9.3	5.6	54	1.08	0.13	0.15	4.2	1,680

* *Nutrient Requirements of Beef Cattle*, Sub-Committee on Beef Cattle Nutrition, National Research Council, revised edition, 1958.

Table 57

MORRISON'S FEEDING STANDARDS FOR BREEDING BEEF CATTLE*

Class of Cattle and Weight (lb)	Requirements per Head Daily: Dry Matter (lb)	Digestible Protein (lb.)	Total Digestible Nutrients (lb.)	Calcium (gm)	Calcium (lb.)	Phosphorus (gm.)	Phosphorus (lb.)	Carotene (mg)
Pregnant Cows								
900	13.1–18.4	0 65–0 70	6.9– 9.7	20	0 044	17	0 037	55
1,000	14.2–20.2	0.70–0 80	7.5–10.5	20	0 044	17	0 037	55
1,100	15.2–21.5	0.75–0 85	8.0–11.3	20	0 044	17	0.037	55
1,200	16.3–22.8	0.80–0.90	8 6–12.0	20	0.044	17	0.037	55
Cows Nursing Calves								
900–1,100	22.0–27.0	1.20–1.40	12.0–15 0	30	0 066	24	0 053	90
Growing Cattle†								
700	14.2–16.5	0 87–0 98	8.9–10.2	17	0 037	15	0 033	40
800	15 9–18.3	0.90–1 00	9 5–10 9	16	0 035	15	0 033	45
900	17.3–19.7	0.93–1.03	10.1–11.5	16	0 035	15	0.033	50
Mature Bulls‡								
1,400	17.2–19 0	1.19–1.31	11.0–12 2	14	0 031	14	0 031	84
1,600	18 6–20 6	1.28–1.42	12.3–13 5	16	0 035	16	0 035	96
1,800	20 4–22 6	1.40–1 54	13.5–14.9	18	0 041	18	0 041	108

* Taken by permission of The Morrison Publishing Co., Ithaca, N. Y., from *Feeds and Feeding*, 22nd edition, by Frank B. Morrison.

† Upper limits of range should be adequate for pregnant yearling or two-year-old heifers.

‡ Assumed to be the same as for dairy bulls as shown in Morrison's tables.

air-dry feed requirement, the remainder being supplied by carbonaceous roughages, the ration will be sufficiently well balanced for dry cows in ordinary condition. Soybean and cowpea hay have almost the same feeding value as alfalfa and red clover. Soybean straw (obtained from threshed beans) is high in crude fiber, since many of the leaves are lost during the process of combining. However, it is an excellent feed for breeding cattle, but it must be fed more liberally than soybean hay. It is approximately half as valuable pound for pound.

Lespedeza hay is an excellent feed for cows if it is cut at the proper stage of maturity. If allowed to become too ripe, the stems are very hard and the hay is much less palatable and digestible. The lespedeza straw obtained when the crop is cut and threshed for seed is nearly worthless for feeding livestock. Dry cows that were given a

full feed of lespedeza straw at the Illinois station showed a pronounced dislike for it and lost 70 pounds in 60 days, whereas similar cows fed 8 pounds of low-grade alfalfa hay and a full feed of oat straw gained 42 pounds apiece.

Although it is true that good quality legume hay when fed as the sole ration may supply more nutrients than needed, especially protein and carotene, it still may be the most economical feed to use, if home-grown, and other roughages are not available. Mixed hay, composed of about half legumes and half grass, is excellent winter feed for cows and meets their nutrient requirements almost exactly.

Grass Hays. Prairie hay, composed principally of the bluestem grasses and similar tall-growing bunch grasses found in native grass meadows of the range states, is the principal wild grass hay fed to beef cows in that region. Improved wheatgrasses, found on the mountain meadows of the Northwest and sometimes on irrigated meadows, are especially nutritious if they are not overly mature when cut. Marsh hay, grown in the North Central States and elsewhere, may be of good quality but varies greatly with stage of cutting and state of the weather during curing. The principal deficiency of native

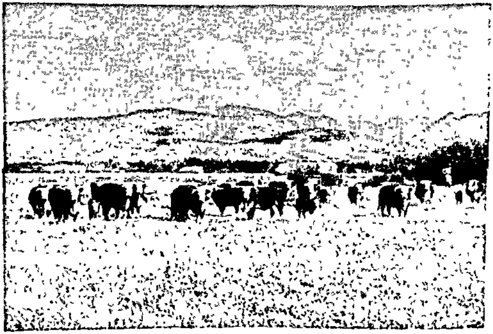

FIG. 48. The stacks of mixed hay in the background, grown on irrigated meadows, will be used to winter the cows and their calves after weaning on this western Wyoming ranch. (The Record Stockman.)

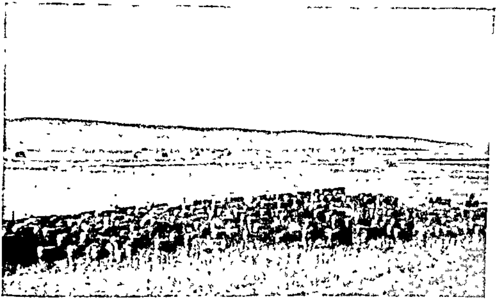

FIG. 49. Prairie hay plus a protein supplement is a common feeding program for wintering stocker steers in the Nebraska Sandhills (The Record Stockman)

hays is protein, but carotene and phosphorus may also be deficient if the hay is too mature when cut. Prairie hay and other grass hays are usually cut at too mature a stage, in order to get more tonnage, but by late cutting actual pounds of digestible protein and energy may be reduced because of increased lignification and consequent lowered digestibility.

DEAD GRASS. A large per cent of the cows wintered in much of the range area and in the Gulf Coastal region obtain the major portion of their winter ration from dead grass, sometimes called "winter range" or cured grass. In general, such range or pasture is especially set aside specifically for this purpose, except in the Gulf Coastal region where year-round grazing of the same area is a more common practice. Cows which must exist solely on such feed are very apt to experience nutritional deficiencies, as demonstrated in Table 58 which shows that protein, phosphorus, and carotene content of the dead grass forages are dangerously low. It is a wonder that production is often reasonably good in cows wintered principally on such forages, but it illustrates that the winter requirements for dry cows, especially if mature and in good flesh in the fall, are not too critical. The weathering damage to dead grass forage is much more severe in the Gulf Coastal regions Here the grasses such as Bermuda, Johnson grass, and switch cane are, first of all, less nutritious to begin with and, in addition,

Table 58

ANALYSIS OF PRAIRIE GRASS AT DIFFERENT SEASONS*
(Three-Year Average)

	Per Cent Dry Matter	Per Cent Composition of Dry Matter							
		Ash	Prot.	Fat	Fiber	N.F.E.	Ca	P	Carotene†
Grass‡									
November	82.39	5 01	2.53	1.74	40.02	50.40	0.253	0.046	14
January	94.85	5.92	2.57	1.57	40.86	48.74	0.309	0 039	*trace*
May	52 29	6.39	9.68	2.40	32.02	49.08	0 308	0.126	407
August	54.71	6 21	5.06	2.23	35.42	50.66	0.346	0.078	112
October	63 09	5.18	3.23	1.62	37.24	52.24	0.244	0.048	16

* *Oklahoma Cattle Feeders Day Report, 1951.*
† Parts per million.
‡ Averages, by species, of the four predominant grasses: big bluestem, little bluestem, Indian, and switch.

rainfall is heavier so that more leaching takes place than in other regions More complete supplementation is required, but fortunately the winters are short and annual grasses often provide bits of protective green forage, even in winter. Energy supplementation often pays in the coastal region. At any rate, cows on dead grass forage should receive at least the equivalent of 1 pound per day of a high-protein supplement plus complete mineral supplementation. Such supplements, incidentally, can be successfully self-fed by including approximately 25 per cent salt in the supplement mixture.

STRAW. Next to corn stover, the straw of small grain crops is the most abundant low-grade roughage material in the country. The value of straw for feeding purposes is determined largely by the stage at which the grain is cut and the amount of damage done by rains before baling or stacking. Good, bright oat straw, cut with a binder when it is a little short of fully ripe and cured in well-constructed shocks, has considerable feeding value and ranks only a little below timothy hay in the amount of total digestible nutrients. This method of harvesting is only practiced to any great extent in the North Central States. Oat straw obtained after a combine is much less valuable than threshed straw because it is cut when it is much riper and consequently is much higher in fiber. Moreover, most of the leaves and chaff, which are the best parts of the straw, are lost during combining and subsequent raking. Straw from barley is of somewhat less value as a feed than oat straw, whereas that from wheat has still less merit. Straw

from bearded wheat or barley is, of course, less satisfactory to feed than that made from the beardless varieties for obvious reasons.

Although dry breeding cows nearly maintain their weight when given free access to bright oat or wheat straw, an exclusively straw ration is not to be recommended. Straw, like stover, is very low in protein and does not supply enough of this nutrient to care properly for the needs of the developing fetus. Moreover, it is non-laxative and tends to provoke disorders of the digestive tract. When combined with other feeds such as corn silage and legume hay, straw is a highly desirable component of a maintenance ration. From the standpoint of cheapness it is almost unexcelled, both because it is to a great extent unmarketable and because little labor is expended in preparing it for cattle. For this reason it is usually desirable to feed the breeding herd the maximum amount of straw consistent with the health of the cows and the proper development of the fetuses. Straw may safely be relied upon to furnish one-half to two-thirds of the total air-dry feed of the winter ration of dry cows.

Corn and Sorghum Fodder and Stover. Corn stover—that is, the stalks left in the field behind a corn picker or field sheller—offers considerable possibility as a roughage for wintering beef cows. As a larger and larger portion of the corn crop has been harvested with mechanical corn pickers over the years, less and less corn stover has been used for cow feed. This is because by the time corn is dry enough to pick for safe storage (15 to 18 per cent moisture content) the stalk is dead ripe and many leaves have fallen. The picker removes most of the remaining leaves, but there are stalk shredders now on the market which pick up both stalk and leaf and deliver them into a wagon in shredded form which can be stored either as stover or made into silage. Molding may result if the shredded stalks contain over 16 per cent moisture when stored for dry roughage. Field shelling of corn earlier in the season when it still contains as much as 30 per cent moisture, followed by drying of the shelled corn for safe storage, means that the corn stalk can be harvested as stover (if it is allowed to field cure) or as stover silage while the leaves still contain some green color. Such stover is less fibrous, hence more digestible, and because it contains more leaves it is more completely consumed. Some models of field shellers or combines cut and shred the stalk at the same time that the grain is removed. Such chopped stover is best stored in a silo because it is likely to be too high in moisture to store as dry stover.

Sorghum stover is somewhat higher in feeding value than corn stover since, first of all, sorghums are sweeter due to their sugar content and

thus are more completely consumed. Secondly, the proportion of leaf to stalk is higher, with the leaves being the more valuable portion. Then finally, in a normal growing season the sorghum head ripens sufficiently for combining and safe storage before the stalk matures. During a year when the harvesting season is delayed by weather or when an early frost kills the plant before it can be combined, sorghum stover deteriorates rather rapidly, especially in areas which receive considerable rainfall.

The almost certain increased use of grain dryers and the consequent earlier harvesting of corn and grain sorghums means that these two forages offer great hope for increasing the supply of low-grade roughages for wintering cows. Cattle programs, other than the cow-calf program, do not utilize these forages very well, however.

Corn and sorghum stover also must be supplemented with at least the equivalent of 1 pound per day of a high-protein concentrate. Rations consisting principally of these forages should be supplemented with vitamin A or carotene, calcium, and phosphorus. Therefore, fortified protein supplements can be justified unless some high quality legume hay or winter pasture is available. Palatability of shredded corn stover is a problem that can be overcome with molasses, but the added cost may not be economically feasible.

Corn and Sorghum Stalk Fields. It is estimated that approximately 90 per cent of the corn in the Corn Belt is harvested for grain and the stalks left standing in the fields These stalks furnish a considerable amount of pasture for cattle during the late fall and early winter months. Particularly good use can be made of them by breeding cows, since the digestive systems of cows are capable of handling large amounts of coarse roughage. Ordinarily, stalks may be relied upon to furnish the major part of the sustenance of the breeding herd during the months of November and December. Stalks, however, are very low in protein and are very dry and non-succulent. Consequently they, like corn stover, should be supplemented with some more nutritious, more laxative feed. For this purpose there is nothing better than a good bluegrass or clover pasture to which the cattle have free access. In the absence of pasture, 4 to 6 pounds of clover or alfalfa hay should be fed daily after most of the ears left by the picker have been eaten and only the dry stover remains. Field shellers, of course, leave few ears.

As a rule, stalk fields have been pretty well picked over by Christmas so that they are of little value for feed after that time, as indicated by the stalk grazing periods shown in Table 59. However, they still retain considerable value as a means of providing exercise for the

Table 59

GAINS MADE BY DRY BEEF COWS ON CORN-STALK PASTURES WITHOUT ADDITIONAL FEED
(Unpublished Data, Illinois Station)

Year	Area per Cow	Period Grazed	Days Grazed	Days Grazed per Acre	Change in Weight
1923	1.0	Nov. 24 to Dec. 18	24	24	−59
1924	1.0	Nov. 26 to Dec. 16	20	20	−19
1925	1.0	Nov. 24 to Dec. 15	21	21	−36 5
1926	1.0	Nov. 23 to Dec. 4	11	11	−36
1931	1.6	Oct. 19 to Nov. 14	26	16	37
1935	2.1	Nov. 9 to Dec. 28	49	23	13

cattle. On days when the ground is frozen and the weather is not too blustery the cows should be turned out in the stalks for a few hours. If possible, one should reserve a field of stalks close to the barns for this very purpose. However, even in a field of rather cleanly picked stalks, cattle wander around to a considerable extent, searching for a stray "nubbin" or a mouthful of undamaged husks. Field shelling, as opposed to picking in the conventional manner, results in higher quality forage if stalk fields are grazed, as is the case when stalk fields are harvested as stover or stover silage.

Sorghum stalk fields are very well utilized by dry cows in late fall and early winter. A sorghum stalk field located adjacent to a wheat pasture being grazed in winter makes an almost ideal combination

FIG. 50. Hereford cows gleaning what the corn picker has left. Cornstalk fields can best be utilized by dry cows or yearling stocker steers (Illinois Experiment Station)

because cattle on high-moisture-content wheat pasture crave a dry roughage such as the sorghum stalks left after combining the sorghums for grain. If cows are to be maintained solely on stalk fields for more than 6 weeks, a protein supplement or some legume hay should be provided.

Corn and Sorghum Stover Silage. Siloing of stover is preferable to shredding or grinding it if the equipment is available. It should be understood, however, that siloing does not make the stover more digestible; it merely renders it more palatable by making the hard, woody stalks soft and succulent. As a result nearly all the stover is eaten, whereas approximately 30 per cent of the weight of dry stover is refused, at least in the case of corn stover. Consequently a given quantity of stover feeds a herd of cows a considerably longer time in the form of stover silage than it would in the form of dry stover. Another advantage of stover silage over dry stover is that its high moisture content reduces the danger of impaction and other digestive disorders sometimes encountered among cows which are fed large quantities of dry corn stover.

An amount of water equal approximately to the weight of air-dry stover siloed must be added if a good quantity of silage is to be obtained. This weight of water is far too great to be blown up the cutter stack along with the dry stover when an upright silo is used. Instead it must be pumped to the top of the silo and added through the distribution pipe. Care must be taken to distribute the water evenly over the silage. Thorough tramping of the silage is necessary to pack it tightly and exclude all air, or spoilage will result. Silage made from stover cut immediately after field shelling or combining needs somewhat less added water to bring the silage to about 30 per cent dry matter content. Cows keep in good thrifty condition on a daily ration of 40 to 50 pounds of stover silage and 4 to 6 pounds of legume hay, or on a full feed of green stover silage plus 1 pound of a protein concentrate daily and free access to oat straw.

Corn and Forage Sorghum Silages. In the Corn Belt and wherever corn and forage sorghums can be successfully grown, corn and sorghum silages are excellent, though not exactly economical, winter feeds for the breeding herd. Because they are moist and succulent they tend to stimulate a good flow of milk in wet cows which calve in late winter or early spring, and they tend to keep the digestive system well regulated, resembling fresh grass in these respects. Their high yield per acre enables the farmer with a limited area to winter a considerable number of cattle. Their physical nature makes for ease and cheapness of storage.

However, these silages alone are not well-balanced rations. They are low in protein in comparison with their carbohydrate content. This condition can be remedied by using a legume roughage or a protein supplement along with silage. The oilseed meals, clover hay, and alfalfa are all rich in protein, and any of them can be used for supplying the nitrogenous material or protein that the animals require. At the Illinois Experiment Station, 10 heifers were carried on corn silage and cottonseed meal alone from the time they were weaned until they had grown to maturity and produced two crops of calves. Altogether, these cattle received only these two feeds for approximately 4 years. No ill effects of any kind were observed, and the calves produced by the cows appeared to be strong and vigorous. It is believed, however, that the ration would have been better from the standpoint of the cattle, as well as less expensive, if some dry roughage had replaced part of the silage.

Corn silage and, to a lesser extent, sorghum silage, because of their grain content are usually considered higher-cost feeds than straw, stover, and other dry roughages which have little cash sale value Consequently these silages usually are fed to commercial cows in limited amounts, along with some cheap, dry roughage which is fed according to appetite. Sometimes no silage is fed until the cows start to calve, when feeding is begun at the rate of 20 to 30 pounds per head daily. Purebred cows, which are best kept in fairly good flesh to enhance the sale value of their offspring, stay in about the desired condition on 5 to 8 pounds of legume hay and a full feed of corn or sorghum silage.

When considered from the standpoint of the acreage required to produce the winter feed for beef cows, corn silage can be justified as a beef cow feed. For example, 6 cows consuming 50 pounds of silage daily for 4 months can be wintered on the forage produced on one acre if the corn silage yields 18 tons per acre, which is an average yield. Few other crops can do so well. Forage-type sorghums are a notable exception, and irrigated meadow land, producing either mixed hay or silage, might approach it.

Hay Crop Silage. Silage made from mixed grasses and legumes is even better than corn silage as a winter feed for dry cows. Because of its high protein, carotene, and mineral content it is an ideal source of nutrients for cows during both gestation and lactation. It is sufficiently low in total digestible nutrients or digestible energy to be fed according to appetite, but better results are usually secured if a small amount of dry roughage is fed to supply variety to the ration. West Virginia station tests of corn silage and legume grass silage, summa-

Table 60

Comparison of Corn Silage and Legume-Grass Silage for Wintering Beef Cows*

	Corn Silage	Legume-Grass Silage
Average initial weight, Dec. 1, 1944, pounds (bred yearling heifers)	807	789
Average final weight, Dec. 1, 1949	1164	1143
Average gain per head	357	354
Average winter ration:		
First winter (yearling heifers)		
Silage, pounds	20	20
Alfalfa hay	6	6
Cracked corn	1	3
Soybean oil meal	.75	...
Average next 4 winters (2- to 5-year-old cows)		
Silage	31.4[a]	27.7[a]
Legume-grass hay	6.5	6 5
Average winter gain (cows plus newborn calves), pounds	94.2	79 8
Average birth weight of calves	66.2	67.3
Average weaning weight of calves (corrected to 180 days of age)	368.5	377.8

* West Virginia Station, Mimeo. Report, 1951.

[a] Silages were fed in such amounts as would furnish equal amounts of dry matter to both groups of cows.

rized in Table 60, disclosed no significant difference between these feeds for pregnant and lactating beef cows when they were fed in such quantities as would furnish the same amount of dry matter. The making of silage from grasses and legumes not needed for pasture during the summer is an excellent way to extend the pasture season, since good-quality hay-crop silage is very similar in physical nature and digestible nutrients to fresh pasture forage. Because of its high protein content, no protein concentrate or legume hay is required; consequently, additional roughage, if fed, may well be straw or corn stover.

Miscellaneous Roughages. A variety of roughages which may be important in localized areas but are not of nationwide interest are also being utilized by beef cows.

Oat Hay and Oat-Vetch Hay. Oats, when seeded alone or when seeded with vetch, makes excellent hay for cows, especially if cut in the soft dough stage.

Oat Silage. If the oat crop is cut for silage at the same stage as for hay, it makes equally as good feed for cows. In fact, because the danger of unfavorable hay-curing weather is eliminated and less oat

grain is shattered, an acre of oats cut for silage will winter more cows than if cut for hay. Neither of the foregoing feeds needs any supplementation for dry cows except a limestone-salt mineral mix. Access to some straw or a cured grass pasture keeps the cows on the silage ration more contented.

SUGAR-BEET-TOP SILAGE. A full feed of this silage plus 2 to 4 pounds of good legume hay makes a good cow wintering ration, but this type of feed is naturally confined to the areas which grow sugar beets commercially. An all beet-top ration is apt to be too laxative, and limestone should be fed by all means to counteract the diarrhea-causing agent, oxalic acid, which this silage contains.

PEA VINE SILAGE. In the vicinity of commercial canneries, pea vines can often be bought for ensiling purposes, or the silage can be bought directly from the company stack. Feeding some hay or even a pound or two of grain may be necessary if thin cows are fed this type of silage, because the silage is sometimes quite unpalatable and thus intake may not be adequate to meet all needs. Corn cannery waste is usually fed to other types of cattle which utilize it better than do cows.

TURNIPS, MANGELS, AND RUTABAGAS. These root crops are more popular in Great Britain and northern Europe than in the United States. They usually contain only about 10 per cent dry matter, and extremely large amounts must be consumed by cows if their energy requirements are to be met. In fact, because of the high water content of such feeds it is recommended that some form of dry roughage be fed in addition to the roots. If the dry roughage fed is non-leguminous, a half pound of high protein concentrate should be added per day.

PRICKLY PEAR. This plant of the cactus family is sometimes used as an emergency feed in the Southwest. The thorns must first be removed by singeing and a completely fortified supplement is required to balance the "pear" ration. It should always be considered as an emergency feed only. Nevertheless, thousands of cows have literally been saved from starvation by the prickly pear during extreme droughts such as those of 1953 and 1957.

CORN COBS. Corn cobs have been used successfully as a source of energy for cows during the winter season. Because of their low palatability and almost complete absence of protein, minerals, and vitamins, they must be fortified with complete balanced supplements that furnish these essential nutrients. Also, the cobs must be finely ground to make them more palatable and to facilitate thorough mixing with other feed materials. One part of ground ear corn, 2 parts of ground corn cobs, and 1 part of ground alfalfa hay fed free-choice through a self-feeder

should maintain beef cows in satisfactory condition during the winter. When no legumes are fed, at least 2 pounds of fortified supplement are needed. If cows increase noticeably in weight on this mixture, the amount of ground cobs should be increased. If they eat less than 2 pounds of the mixture per hundred pounds liveweight, about 1 pound of 50 per cent molasses feed per head should be added to the mixture daily.

GIN-TRASH. Although admittedly a poor quality roughage, this by-product of the cotton ginning process may be used to help carry cows through a winter, especially in emergencies. If supplemented with a high-protein, high-energy substance that is also fortified with minerals and vitamins, a ration consisting largely of gin trash supports dry cows. One to two pounds of fortified supplement are needed for cows in average flesh. If extremely thin, cows need an additional 2 pounds of an energy concentrate such as molasses, sorghum, or corn. Cottonseed hulls and burrs are also used and require the same supplementation.

Winter Pasture. Fall-sown small grains, annual ryegrass, and fescue are examples of winter pastures which can and are being utilized for wintering beef cows as well as other livestock. There is a limit to how far north such a program can be depended upon, but evidently a line drawn through Virginia, northern Kentucky, southern Illinois, northern Arkansas, and northern Oklahoma establishes this northern limit. Fall and winter rainfall and some warm weather are essential for adequate growth to be made in such pastures. On the other hand, too much rain is a severe handicap owing to the problem of grazing the wet fields. Fescue, a perennial grass, is grown in a large part of the wetter areas of the South because it holds cattle up well.

The following statements taken from an Oklahoma pasture research publication[1] point out the value of and the problems involved in winter pasture utilization:

1. The pasture value of winter small grains is so high that livestock farmers might profitably use them entirely for pasture, without taking a grain crop.
2. The protein content of small-grain and annual ryegrass forage, when young, green, and succulent, is high—about 30 per cent or more (dry matter basis) as compared with around 42 per cent in the usual high-protein supplement.
3. The carotene (provitamin A) content is exceedingly abundant. This is an important point, for winter rations in the Southwest are often seriously lacking in carotene. The forage is also high in minerals. Fiber is low—about the same as in alfalfa leaf meal.

[1] Oklahoma Bulletin, No. B-333, 1949.

Carbonaceous concentrates are recommended only when it is evident that the cattle will lose too much weight and condition on the roughage that is available. In this connection it should be kept in mind that it requires much less feed to keep cattle from losing flesh than it does to restore them to the proper condition after they have become thin. Hence it is good economy to introduce a little grain or a high-energy concentrate into the ration as soon as the cattle begin to show signs of undernutrition. Corn, sorghum, oats, and barley are of approximately equal value for this purpose, since the somewhat higher fiber content of oats and barley is largely offset by their higher percentage of protein. However, the addition of any of the common farm grains does not lessen materially the need for a nitrogenous concentrate if all of the roughage is non-leguminous.

Not all cows suckling calves need to be fed grain. However, a majority of cows of beef breeding give comparatively little milk on dry roughage alone, especially if the roughage is of low quality. Whether a larger milk flow is of enough value to justify the feeding of grain usually depends upon the disposition that is to be made of the calves. If the calves are to be fattened for baby beeves, the cows probably should be fed a little grain if they calve more than a month before they are turned onto pasture. Unless good winter pasture is available, cows that calve in the fall usually should be fed 4 to 6 pounds of grain daily during the winter to stimulate a good flow of milk for their calves. The feeding of grain to nursing cows is seldom necessary, however, if corn, sorghum, or grass silage is fed.

Winter Management of Bulls. The winter months are the proper time to condition bulls for the breeding season of the following year. Bulls that have been running out on pasture with the breeding herd are likely to be thin and should have sufficient grain to put them in proper flesh before the arrival of spring. Young bulls should be fed more liberally than old, mature animals, since their growth requirements must be met before any improvement in condition can take place. A grain mixture composed largely of feeding stuffs that are growth-producing rather than fattening is found best for bulls. Crushed oats make a good basal ingredient, to which corn, grain sorghum, or barley may be added only if a marked improvement in flesh is desired. Animals that are in a run-down condition or that show signs of lack of thrift should have 2 to 4 pounds of protein concentrate per day, depending on age and weight. Mature bulls already carrying sufficient flesh may be wintered largely on choice roughages such as legume hay and silage.

Bulls can be kept strong and vigorous during the winter only if

they are given sufficient exercise as well as plenty of feed. To accomplish this end they should have the run of good-sized lots, or better yet, be turned with a few pregnant cows into an adjacent pasture or stalk field whenever the weather permits. When two or more bulls are kept, it is highly desirable to run them together because they will take more exercise when together than when they are alone. Although the turning together of old bulls that are strangers to each other is attended with some risk, a young bull may be put with an older one with comparative safety.

The importance of having bulls in the pink of condition (that does not mean fat, however) at the opening of the breeding season can scarcely be overemphasized. Valuable time is often lost by the use of a bull with impaired sex drive (libido) due to being either too fat or too thin. Examination of semen samples for numbers and normalcy of sperm cells usually determines the fertility of a bull, and often a small or late calf crop can be prevented by such tests.

Western ranchers realize, perhaps better than other cattlemen, the importance of conditioning their bulls previous to the breeding season. They are well repaid for their pains, as shown by the data gathered on 15 ranches in northern Texas by Parr and Kelmmedson over a 3-year period.

> On 10 of the 15 ranches the bulls were taken out of the cow herds in the fall for conditioning and were returned to the cow herds around June 1 of the following year. On the other 5 ranches the bulls were kept with the cows during the entire year. The ranches on which the bulls were removed from the cow herds had a 77 per cent average calf crop for the 3 years, and on the ranches where the bulls were not removed the average calf crop was 64 per cent for the same time.[2]

Whereas the better feed conditions prevalent in the Central States make conditioning of bulls less urgent than on the range or in the coastal regions, more attention to this point on the part of all cattlemen will result in a material decrease in the number of cows that fail to raise calves through no fault of their own.

Wintering Breeding Heifer Calves. Rations for the heifer calves which are to be kept for herd replacements should be composed principally of the better quality roughages available on the farm or ranch. The actual nutrient requirements of heifer calves will be found listed in Tables 66, 67, and 68 in Chapter 11. The level of gain desired depends upon whether the heifers drop their first calves as 2- or 3-year-olds. If the heifers calve first as 2-year-olds, more energy

[2] Parr and Kelmmedson. *An Economic Study of the Costs and Methods of Range Cattle Production*, U.S.D.A. Mimeographed Report, 1924.

is required during the winter in order to insure adequate development prior to breeding the following summer. Meeting the requirements as listed under the sub-heading "Normal Growth for Heifers" in the previously mentioned tables will suffice. If the heifer calves, on the other hand, are not bred until they are two's, they can be wintered according to the requirements listed under the sub-head "Wintering Weanling Calves" in the same tables. In either case the equivalent of 1¼ to 1½ pounds of high-level protein concentrate should be fed daily.

part III

THE STOCKER AND FINISHING PROGRAMS

chapter **11**

OPERATION OF THE STOCKER PROGRAM

A discussion of the development of young cattle logically follows the chapters dealing with feeding and managing the cow herd in winter and summer. No attempt will be made in this chapter to deal with the question of finishing cattle for slaughter, since this program will be treated in special chapters. Rather, we will here confine our attention to calves and yearlings that are not to be finished immediately but are to be handled in such a way that maximum growth is achieved at the lowest possible feed cost. This stocker period, as it is called, consists only of the winter period following weaning, or the period from the time the calves and/or yearlings are weaned until they are sold or put into the feed lot for finishing the following fall. Included in this type of program are the replacement heifers in a cow-calf program which are handled so as to insure normal growth and development. It is customary to refer to the animals on such programs as *stockers,* and they are considered as being on a growing, rather than a finishing ration. *Feeders,* on the other hand, are cattle carrying more finish and bloom, which are placed on more concentrated feeds, or finishing rations, in order to take advantage of the extra condition they possess.

The stocker program is one which is sometimes used as the sole program on a particular farm or ranch, but as often as not, it is either conducted in connection with a cow-calf operation or it precedes the finishing program. When the stocker program is the only beef cattle program on a farm it is generally handled in either one of two ways. In one plan, calves or yearlings are bought in the fall to be wintered on roughage rations in dry lot or on winter pasture and sold in the spring to buyers who need "grass cattle" for the summer, or who need feeders to put on a summer finishing program. In the second plan, in which the operator has summer pasture to utilize, calves or yearlings are bought in the fall to be wintered the same as in the first plan, but instead of being sold in the spring, they are grazed all summer or until

pastures become woody and dry in the fall, or until the onset of winter.

Of course if the farm or ranch also has a cow-calf program, the calf crop from the herd can be handled in the stocker program in the same manner as purchased calves. Ordinarily, however, a farm or ranch suited to the cow-calf program may as well be stocked to capacity with cows in order to increase the size of herd and thus reduce the fixed costs per calf raised. Keeping one's own calves for further grazing as yearlings means that, unless the operation is a large one, both the cow-calf and the stocker program will be reduced in size. If calves from one's own herd are fed out in dry lot as baby beeves, that is another matter, since it would not be likely to reduce the maximum size of cow herd.

Perhaps the most common type of stocker program is the combination stocker-feeder program. The cattle feeder purchases steer calves or yearlings of good to choice quality in the fall or as early as August 1 if available. He wants the cattle early in order to utilize fall growth in small-grain stubble fields, stalk fields, and similar aftermath. A common mistake is to leave the cattle too long on such fields. When gains are reduced to a low level the stockers should be brought into the feed lot. They are then fed a heavy feed of roughage, preferably corn silage plus supplement or legume hay, until the cattle reach a stage of condition at which gains are no longer economical. This point is usually reached after about 3 to 4 months with yearlings and by spring with calves. Having reached feeder condition the steers are then finished out on a full feed of grain, either in dry lot or on pasture, to be sold in late summer or fall. Lower grades of steers and most heifers are not suitable for the stocker program, because such cattle usually are placed on finishing rations soon after they are obtained in the fall, in order to market them in the spring when the prices for such cattle are more favorable. An exception would be choice or better heifer calves which have sufficient quality to justify carrying them to choice or prime condition.

Advantages and Disadvantages of the Stocker Program. This program has the following advantages over other programs:

1. The program is adapted to an intensive type of farming—that is, a large volume of business can be done on small farms which can produce large tonnages of roughages.
2. Returns come quickly, as early as 4 to 6 months, if not preceded or followed by other programs.
3. If used in winter only, this program is finished by the time labor is needed for spring and summer farm work.

4. With this program one can take advantage of a normally rising cattle market. Normally a favorable price spread occurs between fall purchase prices and spring selling prices owing to the supply and demand pattern found in the stocker cattle business.

5. Stockers can utilize large quantities of harvested roughages and aftermath.

6. The stocker program is quite flexible; adjustments in size are easily made.

7. Death losses are lower than in the cow-calf program.

8. Little equipment is required, although the use of equipment for mechanical handling of silage or other roughage reduces labor requirements.

Some inherent weaknesses of the stocker program are:

1. Much capital or available credit is required as compared with the cow-calf program.

2. Buying and selling skill are extremely important in this program because shrink and other losses on both ends, and mistakes in judging quality or in judging the health of the stockers can quickly offset the cheap gains that may be made.

3. The stocker program has peak labor loads; for example, roughage harvesting time and the winter feeding period.

4. The program carries above-average risk. Total gains made are not large in proportion to the weight purchased, so profits must come both from a favorable price spread between buying and selling prices, and from added weight made at feed-and-labor costs that are lower than the selling price. The latter is not difficult to achieve with stockers but, as just mentioned, the total weight to which this factor may be applied is comparatively small, placing considerable burden on the price spread.

It should be mentioned that large commercial feedlot operators who have a more or less continuous type of operation would do well to make most of their stocker purchases during the favorable fall season, carrying the cattle along on stocker rations until they are needed to replace finished cattle in the finishing pens. Sometimes early spring is a favorable time to buy stockers in the wheat pasture area of the winter wheat belt, but this situation should not be depended upon without alternatives.

Market Classes and Grades of Stockers and Feeders. Throughout the year, many thousands of cattle are marketed daily in the large central markets and by direct sale or purchase on farms and ranches.

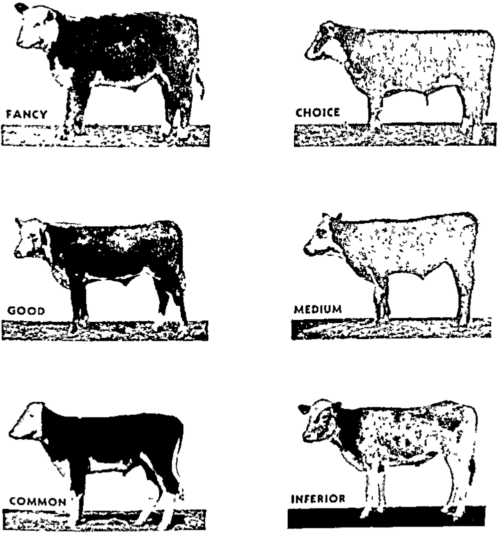

FIG. 51. U. S. grades of stocker and feeder steers. In planning a feeding program the choice of grade depends upon many factors, but mainly on the amount and quality of the feed supply. (U.S.D.A.)

appraisal of the extent to which the animal meets certain established standards as to conformation, quality, breeding, constitution and capacity, and condition or finish. Figure 51 shows what is expected of stocker and feeder calves with respect to the various grades. Yearling steers and the other classes of stockers and feeders would be expected to show comparable characteristics for the respective grades, as would the other beef breeds as well, of course. In practice, the upper three grades are further subdivided into three sub-grades. For example, in the choice grade, market men speak of low choice,

These cattle are of every kind, displaying a wide range of combinations of the various characteristics such as sex condition, age, weight, size, shape, breeding, and flesh condition. There is fortunately a market for each kind of cattle and the variation in prices received reflects both the demand for each kind and the variation in the degrees of merit for uses for which each kind is purchased.

The need for standardization in describing the various kinds of cattle has long been realized. As early as 1902, Prof. H. W. Mumford culminated his studies of the subject with the publication of Illinois Experiment Station Bulletin No. 78 entitled "Market Classes and Grades of Cattle with Suggestions for Interpreting Market Quotations." In 1918 when the Bureau of Markets, now the Bureau of Agricultural Economics, of the United States Department of Agriculture inaugurated its market reporting service on livestock at Chicago, the market classes and grades of cattle as described in the above publication were used as a basis for establishing the terminology and classification of cattle for cattle-market reporting purposes. It is a tribute to the early workers who pioneered in this field more than a half century ago, that the classes and grades of cattle have since been changed only slightly. The use of uniform descriptions of all classes and grades of cattle the country over by producer, selling and buying agencies, and packers has contributed much toward more orderly marketing of stocker, feeder, and slaughter cattle.

The official standards for live cattle as developed by the U.S.D.A. and as generally used today provide for segregation, first, according to use—for example, stocker, feeder, slaughter—second, as to class, which is determined by sex condition, and, third, as to grade, which is determined by the apparent relative excellence and desirability of the animal for its particular use. Table 61 shows how stocker and feeder cattle are grouped according to sex condition and grade.

The grade assigned to a stocker or feeder is based on a correct

Table 61

Market Classes and Grades of Stocker and Feeder Cattle*

Class (Sex Condition)	Market Grade
Steer calves and yearlings	Fancy, choice, good, medium, common, inferior
Heifer calves and yearlings	Fancy, choice, good, medium, common, inferior
Cows	Fancy, choice, good, medium, common, inferior
Bulls	*Ungraded*
Stags	*Ungraded*

* Based on U S D.A. Circular 505.

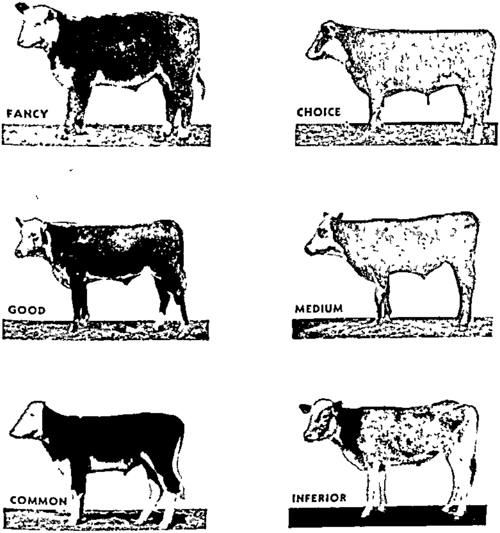

FIG. 51. U. S. grades of stocker and feeder steers. In planning a feeding program the choice of grade depends upon many factors, but mainly on the amount and quality of the feed supply. (U.S.D.A.)

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average choice, and high choice. It should be pointed out that the latter sub-grades are not a part of the standard government grading system.

A brief description of the characteristics which typify each grade of stocker and feeder follows:

Fancy stocker and feeder cattle approach the ideal in beef type or conformation, possessing all the characteristics, except high degree of finish, which will ultimately lead to prime slaughter cattle if fed

FIG. 52. A drove of high-choice and fancy calves. Dehorning would have increased the selling price of these calves by 5 to 10 per cent. Note uniformity, good heads, width of body, and straightness of lines. (American Hereford Association.)

long enough. Compactness, thick natural fleshing, symmetry and balance, and quality are developed to the highest degree. A drove of such cattle is uniform in type and color and, because only a small proportion of the stocker and feeder cattle supply is good enough to make this grade, they command a substantial premium in price when either sold or purchased. In the trade, such cattle are usually spoken of as "reputation brands," and they are ordinarily not found for sale in central markets, but rather are either sold at feeder cattle auctions or are contracted for on the farm or ranch. Fancy calves are usually carrying considerable bloom and finish and thus should be handled in such a program as makes the fullest use of this bloom and condition. Seldom does it pay to place fancy calves on a stocker program; they should rather be placed on a full feed almost as soon as practical. Fancy grade home-raised calves make ideal feeders for the baby-beef program, a program in which they are very likely finished as early as possible. Fancy feeders should be fed to prime slaughter grade in order to command the selling price needed to offset the premium price paid for them. Fancy heifers are seldom available for feeding purposes, because such heifers are generally retained as herd replacements or are sold for higher prices to start new herds.

Choice stocker and feeder cattle, especially those found at the lower end of the grade, are the most numerous grade in American feed lots. Choice cattle resemble fancy cattle but they lack the eye appeal of the top grade. Whereas they are moderately wide, compact and low-set, they may possess somewhat more scale and frame, and they may show some signs of coarseness, lacking the refinement and quality of fancy feeders. They usually show evidence of being good-doing cattle with considerable thickness and depth, but they may be somewhat lacking in straightness of lines and in balance. They are more uneven as to type, weight, and breed characteristics. Cattle feeders who choose this grade are often fortunate enough to top out part of a drove for further feeding to prime grade. Cattle of this grade are usually fed for at least 5 months if put on feed as yearlings, and at least 6 or 7 months if started on full feed as calves

Good grade stockers and feeders have the appearance of thrifty cattle with moderate thickness, but they are generally quite rangy, upstanding, and lacking in balance. Many of the cattle in this grade are thinner in condition than the two upper grades, and thus are better suited for feeding on heavy roughage rations followed by a short feed on finishing rations. Often an alert buyer spots a potential low-choice slaughter cattle end on a drove of good grade feeder cattle, which would well be fed longer to upgrade them into choice. Many

steers originating in the wheat pasture and bluestem grazing areas are cattle of this grade, although there are cattle of the better grades in these areas as well. Good grade cattle usually show the color markings of the principal beef breeds. Many of the yearling heifers that are sold for feeding purposes fall in this grade.

Medium feeders are lacking in beef conformation. They are long, shallow, and narrow, and often show evidence of mixed dairy breeding. Often they are the result of crossing beef bulls on cows of either dairy or scrub native breeding. It is likely that they have not made a profit for the breeder, but they may be quite profitable for the feeder. Because of their growthiness and size they often gain quite well on heavy roughage programs. Gains must be made very economically and the price paid for this grade of feeder must be low, because the selling price is never very high. The feeding period is necessarily short because these cattle can easily be finished beyond a point where the gains cost more than the selling price. Expert

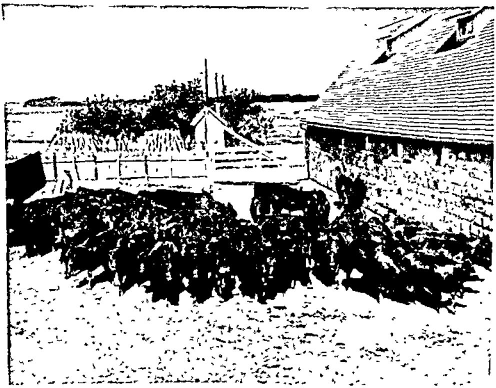

FIG. 53. A drove of choice heifer calves, suitable either for herd replacements or as feeders. Large droves of uniform Angus feeders are less numerous at present than Herefords and consequently they usually command a premium in price. (American Angus Association.)

judgment is required in feeding this grade of cattle because speculative risks are high. Heifers of this grade are rarely available in large numbers because they already have been more profitably marketed as slaughter calves. As slaughter cattle, medium grade feeders usually grade standard, if young, or commercial, if mature.

Common and *inferior* feeders, being at the bottom of the quality scale, can best be described by saying that they lack beef characteristics. They are of nondescript breeding and color and often are unthrifty. Although some of this grade of cattle may make good gains for short periods, the low selling price and the rather numerous stunted individuals that perform poorly make this grade of feeder a very risky proposition. Carcasses produced from cattle of this grade generally grade utility.

It is seldom advisable to feed anything but the good and choice grades of cattle in strictly stocker feeding programs. The lower grades seldom sell well enough as feeders to someone else for further feeding to make a growing program pay. The man who finishes the lower grade of cattle usually does best not to delay too long in getting his cattle fed out and marketed.

Buying Stockers and Feeders. Stocker programs should be so planned as to take advantage of the seasonal fluctuations in supplies, and therefore price, of such cattle. Figure 54 shows that the fall months are the months of heaviest movement in stocker and feeder cattle, whereas the spring and early summer months are the lightest. Figure 55 clearly shows that prices react to the supply situation and that stockers and feeders can be bought much more favorably in the fall months.

Sources of Stocker and Feeder Cattle. Principal sources of stocker and feeder cattle and the relative importance of each source vary from area to area and even from community to community. The principal sources are:

1. Public (terminal) markets, either from dealers or commission firms.
2. Local dealers.
3. Directly from ranchers or farmers.
4. Auctions.
5. Contract arrangements.

A survey made in 8 counties in Illinois,[1] which included 123 feeders

[1] *Buying and Selling Feeder Cattle in Illinois*, Illinois Experimental Station Bulletin 511

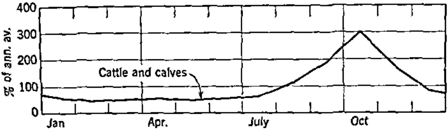

FIG. 54. *Seasonally heavy shipments of stockers and feeders occur in the fall* months of September and October. (U.S.D A.)

and 270 different lots of cattle, revealed some interesting information concerning the source and area of origin of feeders. The counties surveyed would be rather typical of much of the Corn Belt area. The survey showed that the cattle feeders bought their stockers and feeders from the following sources: public stockyards, 46 per cent; local dealers, 36 per cent; direct from grower, 12 per cent; auctions. 4 per cent; other, 2 per cent.

In the same survey referred to above, the area of origin was determined. Figure 56 shows that ranchers in the Northwest sell more of their feeders to local dealers who, in turn, sell them to cattle feeders. On the other hand, southwestern ranchers and farmer-breeders with smaller herds in Missouri and Arkansas sell mostly through public stockyards. Even here, dealers play an important role since they will have purchased the feeders from the rancher at the public stock-

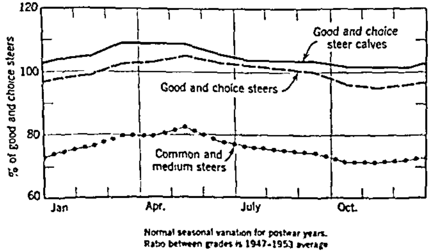

FIG. 55. Seasonality in prices of stocker and feeder cattle at Kansas City, one of the more important central markets for such cattle. (U.S.D.A.)

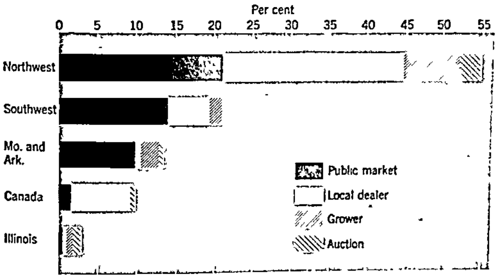

FIG. 56. Percentage of cattle moving to 123 feeders from each area of origin and through each source of purchase. (Illinois Experiment Station.)

yards, only to offer them for sale immediately to prospective feeder-buyers.

Outside the Corn Belt the relative importance of the public market as a source of feeder cattle is considerably less. Buying in auctions and directly from neighbors is more common in areas where number of feeders fed per farm is smaller and cattle feeding is of relatively less importance.

Methods of Buying. There is an old saying which goes, "Well bought is half sold." Certainly this adage applies to the buying of stocker and feeder cattle. An inexperienced feeder should not attempt to buy his own cattle. Instead he should place an order with a dealer, commission firm, or order buyer who knows his business and, preferably, who knows the feed situation of the particular farm, the capabilities of the feeder, and how much risk the feeder can afford to take. The commission charge is small compared with the savings usually made. This is not meant to imply that people who have feeder cattle for sale are dishonest, but it is naturally just as much their business to sell their own or their client's cattle well as it is for a feeder to buy them well.

The methods of buying can be enumerated as follows:

1. *Buying directly from rancher or neighbor* by oral or written contract. Cattle for fall delivery are usually contracted for during the summer. Price, weighing conditions, sort if any, date of delivery,

method of transportation, and arrangements for paying for the cattle should all be agreed upon in advance and preferably verified with a written, signed contract. Beginners should by all means avoid driving out to the range areas, shopping for bargains from ranch to ranch. Much time and money can be wasted and seldom can cattle be bought satisfactorily in this manner. It is the belief of many experienced feeders that this type of practice on the part of an increasing number of cattle feeders has upset normal channels of buying and selling feeder cattle.

2. *Placing an order with a commission firm or dealer.* In this situation the buyer makes his wants known, preferably 3 or 4 months in advance of normal delivery season. The commission firm or dealer locates the cattle, negotiates for them, and makes all necessary arrangements for shipping, et cetera. Upon delivery the cattle are paid for, with the commission firm or dealer acting as the go-between. Pay weight is usually the weight paid for by the feeder. This amount varies, but pay weight is usually the shipping point weight less 3 per cent. Freight, insurance, feed costs in transit, commission, and miscellaneous costs are added to the original negotiated price. Sometimes the commission firm or dealer pays for and assumes ownership of the cattle in order to compute more simply the incidental costs and values, in case shipments from a particular ranch may be divided and sold to more than one buyer. Of course some commission firms also pay for cattle which have not been specifically ordered and assume ownership in order possibly to sell the feeders at a profit. Cattle bought through a commission firm are usually not seen by the buyer until delivery. The buyer is consequently depending upon the reliability of the firm with which he deals.

3. *Buying directly from a dealer.* Some feeders prefer this method because they say they can see what they are buying, and the "asking price" usually covers all costs. Naturally the asking price is as high as the demand allows. Sometimes original pay weight and sometimes delivery weight is used to determine price. This method of buying is convenient since dealers are often located in the midst of the feeding territory, although every terminal market also has numerous dealers.

4. *Buying in person at feeder cattle auctions.* The number of feeder cattle auctions is increasing, especially in areas which are comparatively new in the cow-calf business, such as the Southeast, the Corn Belt, and the South. In sales sponsored by cattlemen's associations, large numbers of stocker and feeder cattle are brought together and sorted or graded into lots which are uniform as to grade and weight. They are then auctioned in truckload lots to the highest

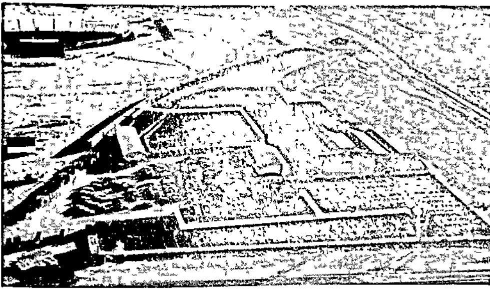

FIG. 57. Well-managed auction sales with convenient truck and rail loading facilities are gaining in prestige and popularity as a source of stockers and feeders (Schnell Livestock Auction Market, Dickinson, North Dakota.)

bidder. When a good-sized crowd is present, bidders may become overenthused and actually pay more than the cattle are worth. Cattle may sell with more fill than cattle bought elsewhere, and cattle which appear uniform at time of purchase as a result of the sorting may soon grow uneven because they came from several different farms. On the other hand, since selling costs, freight costs, and profits to middlemen may be lower or entirely absent, delivered or on-the-farm costs are likewise often lower.

Buying in "community sale" auctions is practiced by many smaller feeders. This method of buying requires extreme skill, especially if cattle must be bought "by the head" rather than by weight. Seldom can uniform lots of cattle be put together, and the chance of buying diseased, stale, or over-exposed cattle is high. It should be said that most auctions of this type operate under the highest of standards and in some localities they are the only source of stocker and feeder cattle.

Transportation of Stockers and Feeders. Railroads haul most of the stocker and feeder cattle from the range states if their destination is east of the Mississippi River, because rail shipment is cheaper than other methods in this situation. The cattle are delivered to terminal markets, dealers' yards, and sometimes to holding pens on railroad sidings near the feeders' farms. Trucks are used to move cattle shorter distances, such as from producer to loading point and

from terminal markets, dealers' yards, and auctions to the farm, because of the convenience of this type of transportation in these situations. Many stocker and feeder cattle, of course, are also trucked directly from producer to feed lot if distances are not too great.

Railroads are required by law to unload, feed, water, and rest cattle every 28 hours, except when the owner gives written permission for a "36-hour-release," which is permissible if the haul is less than 36 hours in length. This helps insure delivery of the cattle in better condition with less shrink, since they will not lose the minimum 5 hours otherwise required for a rest stop.

Shrink from Source to Feed Lot. Shrink may be of two types in stocker and feeder cattle. *Excretory shrink* is the loss in weight due to loss of manure and urine and this shrink can be regained in a short time. On the other hand, *tissue shrink* is actual loss of flesh and

FIG. 58. Mixed yearlings being loaded at a country point in Idaho. Fast, high-priority trains on the main lines shorten the time en route to the Corn Belt destination by many hours, reducing shrink and danger from stress due to long delays. (The Record Stockman.)

body water and this type of shrink is regained much more slowly. The length of the trip, previous feeding, and temperature affect both amount and type of shrink. Most of the shrink on a short trip on a hot day, when fill at loading time has been heavy, would be excretory shrink. Sappy, milk-fat calves, shipped on a week-long trip, may incur heavy tissue shrink, especially if they do not drink much at rest stops.

It is difficult to make general statements as to what constitutes normal shrink for stocker and feeder cattle. Calves may shrink up to 10 per cent or more while heavy cattle may not shrink over 4 or 5 per cent. The time required to return to pay weight is perhaps as important as difference in pay weight and delivery weight, because all feed fed during the shrink recovery period is added cost. This period of time may vary from less than a week for older, heavy cattle to as much as a month for calves or stale cattle. An outbreak of shipping fever during this shrink-recovery period drastically alters the time required to return to pay weight.

Home-Grown Stockers and Feeders. Even in the heavy cattle feeding areas in the Corn Belt there are large numbers of brood cows in rather small farm herds, and of course the same holds true throughout the Southeast and in the Great Lakes regions where cow numbers have increased greatly during the last 15 years. Calves or yearlings produced in these herds are often fed out on the farm where they are produced, but still others are offered for sale locally. There are both advantages and disadvantages to buying local or native feeder and stocker cattle. They may be summarized as follows:

Advantages of native or home-grown stockers and feeders:

1. Native stockers and feeders are more apt to escape shipping fever and similar diseases, especially if bought direct on the farm where produced.
2. Delivered price may be lower because of lower freight and buying costs or because of less demand for local calves.
3. Shrink, especially tissue shrink, may be lower. Of course there is no shrink at all in home-grown cattle.
4. Native stockers and feeders do not have to adjust to sudden changes in environment.
5. Native cattle are somewhat accustomed to the feeds produced in the area.

Disadvantages of native or home-grown stockers and feeders:

1. They are quite likely to be less uniform in quality, condition, and age.

2. Native or home-grown stockers and feeders may be lower in quality than those purchased in the traditional range areas, but this situation is not always true.

3. Such cattle are likely to be fleshier and thus do not make such large, economical gains on roughages.

4. Several purchases have to be combined to meet the needs of cattle feeders who desire to feed more than a car or truckload of cattle.

5. Native stockers and feeders may not be available in large enough numbers at the usual time for buying such cattle, that is, in the late summer and fall.

Pay weight is the weight at the producer's farm or at the loading point, less whatever allowance for shrink, if any, the buyer can negotiate for. The most common practice in the range area is to allow the buyer a 3 per cent shrink—that is, the calves or yearlings are weighed at the producer's ranch or at the loading point; then 3 per cent of the weight will be subtracted. Final settlement is based on the calculated pay weight. If cattle must be driven some distance, no shrink may be allowed, or if cattle are lotted overnight without feed or water, only 1 or 2 per cent, or possibly no shrink is deducted. The delivered weight is subtracted from pay weight to determine how much shrink took place on the weight of feeder cattle paid for. The method for determination of pay weight should be agreed upon in advance, by all means, in order to prevent misunderstanding.

Disease Problems and Death Loss in Stocker and Feeder Cattle. Losses due to disease and accident are highest in stocker and feeder calves and less in older, heavy cattle. A survey of reports on 113 droves of cattle fed by Farm Bureau Farm Management Service cooperators[2] showed that death losses of calves were 2.43 per cent; yearlings, 0.85 per cent; 2-year-olds and over, 0.43 per cent. Most of these losses are due to diseases contracted somewhere between the producer and the feeder. Hemorrhagic septicemia or shipping fever is the principal disease causing losses. This and other diseases will be more fully discussed in Chapter 29.

"Laid-In" Cost of Stockers and Feeders. The buyer of stocker and feeder cattle is of course interested in buying his cattle as cheaply as possible without sacrificing quality. The rancher or breeder is just as interested in selling as high as possible. However, the buyer always pays more than the grower receives. There are numerous items of expense from ranch to feed lot, and these are all added to the

[2] M. L. Mosher, "Death Losses in Livestock on Illinois Farms," *Illinois Farm Economics*, June, 1947, p. 533.

purchase price by the time the cattle are "laid in" or are safely unloaded at their new home. Not all of the following items are included in every case, although most of them are. Charges naturally vary somewhat from area to area.

Items of expense in purchasing stocker and feeder cattle:

1. *Freight.* Freight varies with distance and method of hauling, but it ranges from 15 cents per hundredweight for locally bought cattle to as much as $1 per hundred for cattle requiring a long haul.

2. *Commission and buying expense.* This charge applies only when a buyer has placed an order with a commission firm or order buyer. It may range from 10 to 20 cents per hundredweight depending upon services rendered.

3. *Transit insurance.* Insurance is usually figured by the head, but it can be broken down to a hundredweight basis and varies from 3 to 6 cents per hundredweight depending upon distance hauled.

4. *Feed and labor of feeding en route.* Feeding cost varies tremendously depending upon how many rest stops must be made, but it may amount to 10 or 15 cents per hundredweight.

5. *Trucking from railroad to farm.* The size of this item depends upon distance hauled, and it may vary from a low of 15 cents to 50 cents per hundredweight if the haul is as much as 200 miles

6. *Personal expenses on the buying trip.* Some buyers who go to the West to buy cattle may mark the trip off as vacation expense, but usually one or more special buying trips are necessary, even if only to the local feeder yard. In any case, this expense must be borne by the newly acquired stocker or feeder cattle. A reasonable estimate of this item is from a few to 20 cents per hundredweight.

The items listed above usually add a total of 75 cents to as much as $2 per hundredweight to the purchase price of stockers and feeders and must be added in calculating the "laid-in" cost. Naturally locally purchased cattle, hauled in the buyer's truck, have little of this type of cost added.

Shrink and death loss occurring on the farm have already been touched upon, but actually these items of expense can well be added to the laid-in price of the feeders before final calculations of profit or loss are made The same can be said for financing costs, or interest and carrying charges on borrowed money which is used to buy the feeder cattle For example, a 4 per cent loan for 1 year on a long-fed calf costing $100 and weighing 400 pounds at time of purchase adds $1 per hundredweight to the cost of the calf

Feeding and Management of Stocker Cattle. In planning the management of stocker cattle it should be kept in mind that such animals are kept for three reasons: (1) to insure a supply of the right kind of cattle for the feed lot at the proper time; (2) to utilize farm roughages, otherwise unmarketable; or (3) to "cheapen down" the feeder cattle. No matter which of these objects is uppermost in the mind of the owner, economy in feeding and management is of the utmost importance.

Winter Gains of Stocker Cattle. Stocker cattle should be maintained with the minimum outlay for feed consistent with health and vigor. Increase in weight beyond that represented by normal growth is not to be expected. In fact, a noticeable increase in condition is usually undesirable if the steers are to make the most efficient use of grass the following spring and summer. With cattle in ordinary flesh at the beginning of winter, daily gains of 1 to 1½ pounds should be considered satisfactory. The amount of gain necessary to account for normal growth depends, of course, upon the age of the animal. Table 62 shows the result of an early experiment demonstrating the levels of daily gain which constitute normal growth without fattening for annual periods up to 1, 2, and 3 years of age. Growth is most rapid in young animals and gradually decreases as the animals approach maturity. Hence, calves make larger gains than yearlings, and yearlings more than 2-year-olds, when all are on the plane of nutrition which permits normal growth but little or no improvement in condition. In fact, 2-year-old steers grow so slowly that it is seldom advisable to carry them on non-fattening rations except for relatively short periods. Since they require a large amount of feed for maintenance, gains that represent only slow growth in older cattle are very expensive.

Table 62

YEARLY GAINS MADE BY CATTLE ON DIFFERENT PLANES OF NUTRITION*

Period (Age of Cattle)		Group I (Maximum Growth Without Fattening)	Group II (Growth Distinctly Retarded)
30 to 360 days	Weight gained	409.7 lb.	241.6 lb.
	Daily gain	1.24	0.73
360 to 720 days	Weight gained	320.8	235.6
	Daily gain	0.89	0.65
720 to 1080 days	Weight gained	126.9	121.2
	Daily gain	0.35	0.34

*Missouri Research Bulletin 43.

Table 63

EFFECT OF WINTER GAINS UPON GAINS MADE ON GRASS DURING THE FOLLOWING SUMMER*

	Winter Gains (Pounds)	Gains Following Summer and Fall (Pounds)	Total for Year (Pounds)
Average of 4 lots, making less than 50 lb. winter gains	20	257	277
Average of 7 lots making 50 to 99 lb. winter gains	77	235	312
Average of 6 lots making 100 to 149 lb. winter gains	121	227	353
Average of 4 lots making 150 to 199 lb. winter gains	167	212	379
Average of 5 lots making 200 or more lb. winter gains	222	165	387

* Oregon Bulletin 182.

As far as possible, the winter ration should prepare the cattle for making the maximum use of the summer ration. It is a well-established fact that half-fat cattle or cattle carrying a noticeable amount of condition do not do well when turned on grass in the spring. Indeed, it sometimes happens that such cattle actually lose weight during the first 3 or 4 weeks of the grazing season. This situation is particularly likely to occur when cattle that have received a liberal grain ration during the winter are turned on grass and the grain feeding is discontinued. The amount of gain made in summer varies inversely with the amount of gain made during the winter, as seen in Table 63 Consequently, if cattle are being wintered for the purpose of converting grass alone into beef the following summer, the winter gains should not be so large that the cattle's ability to utilize grass is impaired.

Theoretically it would appear that cattle making no gain, or even losing slightly in weight during the winter, would make the best use of grass This statement is true for the summer period only, and such cattle, if not so thin as to be unthrifty, are often a profitable purchase at the beginning of the grazing season However, the man who winters his own steers is interested in total gains for the entire period rather than those of the summer alone Probably from three-fifths to three-fourths of the total yearly gain should be made from grass or other roughage if the maximum profit is to be realized

The amount of gain desired during the winter depends largely upon the way the cattle are to be handled the following summer. If they are to be fed concentrates on pasture, they should be wintered better than if they are to be only grazed. Also, if they are to be grazed only until midsummer and then full fed for the late fall market, they should be wintered at a higher level than would be advisable if they were to be grazed the entire summer and fall. This recommendation is especially important for yearling cattle, which are difficult to fatten during a short feeding period unless they are in fairly good flesh when they are started on feed.

Table 64 shows the effect of level of winter gain upon the gains made the following summer when handled under three different summer management programs. Total gains for winter and summer are also shown. In fertile areas where the yields of roughages such as corn and sorghum silage are high, wintering gains can often be made more economically than summer gains resulting from finishing rations fed on pasture. Therefore it seldom pays to skimp on wintering rations for cattle which are to be fed during the summer.

Although it is true that the less the gain made by young cattle during the winter the more they gain on pasture the following summer, the winter and summer gains are not inversely proportional, as is often believed. For example, if one lot of steers gains twice as much during the winter as a second lot, its summer gains are not limited to half those of the second lot, but will probably be 70 to 90 per cent as much. Consequently, it usually happens that the cattle which make the largest winter gains also make the largest total gain for both periods. Although the effect of the winter gain on the summer gain varies widely from year to year and between different droves of cattle, a good rule for the practical cattleman to follow is that for every additional pound that stocker calves gain during the winter, they will gain ½ pound less during the following summer. Calves that gain less than 250 pounds during the winter, or less than 1.5 pounds per day, usually do not gain enough during the summer to weigh in the fall what they would have weighed had they been wintered on a higher level of nutrition.

Recommendations for level of winter gain for stockers that are to be handled according to the more common steer management plans during the following summer are shown in Table 65.

Nutrient Requirements for Stocker Cattle. National Research Council recommendations for the daily nutrient needs for wintering stocker calves and yearlings and for normal growth are shown in Table 66, whereas the recommended percentage nutrient content of

Table 64

EFFECT OF LEVEL OF WINTERING GAIN UPON SUMMER AND TOTAL GAIN*

	Winter Gains (100 Days)		Daily Summer Gains and Total Winter Plus Summer Gains — Summer Programs (100 Days)						All Summer Programs	
			Pasture Only		Full-Fed on Pasture		Full-Fed in Dry Lot			
	Av. (lb.)	Total (lb.)	Av. Daily Summer Gain (lb.)	Total Summer + Winter Gain (lb.)	Av. Daily Summer Gain (lb.)	Total Summer + Winter Gain (lb.)	Av. Daily Summer Gain (lb.)	Total Summer + Winter Gain (lb.)	Av. Daily Gain — 100 days (lb.)	Total Gain — 200 days (lb.)
No. of Steers	60		20		20		20			
Lot										
1	0.92	116	1.42	288	2.70	416	2.35	381	2.17	363
2	1.25	200	1.35	335	2.00	400	2.12	412	1.82	382
3	1.51	231	1.10	341	1.55	380	2.00	431	1.55	380
4	1.61	262	1.05	367	1.60	422	1.90	452	1.51	413
5	1.65	263	0.92	355	1.82	445	2.12	475	1.62	425

* Illinois Cattle Feeders Day Report, 1953.

rations for the same classes of cattle is shown in Table 67. If more or less gain is desired than that shown in the NRC recommendations, the T.D.N. and Digestible Energy values need to be adjusted upward or downward slightly, but this does not apply to the remaining values. Morrison's feeding standards for the same classes of cattle are shown in Table 68.

Winter Rations for Stockers. As has already been stated, the wintering of stock cattle is not likely to prove profitable unless the ration consists largely of farm-grown roughages. The presence of much grain in wintering rations is not justified. As a matter of fact, it is seldom necessary to use any grain at all for yearling cattle. Calves usually require 3 to 5 pounds of grain daily to insure satisfactory gains unless they are fed almost a full feed of corn or sorghum silage. In the absence of some kind of legume roughage, it is highly advisable to feed a high-level protein supplement to supply the protein requirements of the growing animals. Usually 1 pound of

Table 65

RECOMMENDED WINTER GAINS FOR STOCKER CATTLE
(120–150 Days)

Method of Feeding and Management the Following Summer	Calves		Yearlings		2-Year-Olds	
	Total (lb.)	ADG (lb.)	Total (lb.)	ADG (lb.)	Total (lb.)	ADG (lb.)
1. Grazed entire summer; sold as feeders or started on feed in late fall (Nov.)	115	0.75	100	0.66	50	0.33
2. Grazed until Aug. 1, full-fed until late fall or early winter (Nov. or Dec.)	150	1.00	115	0.75	75	0.50
3. Pastured only until about June 1, then full-fed on pasture and marketed late fall (Nov.)	185	1.25	150	1.00	115	0.75
4. Full-fed during summer in dry lot; marketed in early fall (Sept.)	225	1.50	185	1.25	150	1.00
5. Full-fed during entire summer on pasture; marketed in fall (Oct.)	225	1.50	185	1.25	150	1.00

Table 66

DAILY NUTRIENT REQUIREMENTS OF STOCKER CATTLE*

(Based upon Air-Dry Feed Containing 90 Per Cent Dry Matter)

Body Weight (lb.)	Av. Daily Gain (lb.)	Daily Feed per Animal (lb.)	Total Protein (lb.)	Digestible Protein (lb.)	Daily Requirement per Animal: Total Digest. Nutrients (lb.)	Digestible Energy (therms)	Calcium (gm.)	Phosphorus (gm.)	Carotene (mg.)	Vitamin A I.U. × 1000
				Wintering Weanling Calves						
400	1.0	11	1.1	0.7	6.0	12	13	10	7	2.8
500	1.0	13	1.3	0.8	7.0	14	13	10	9	3.6
600	1.0	15	1.4	0.8	8.0	16	13	10	10	4.0
				Wintering Yearling Cattle						
600	1.0	16	1.3	0.8	8.0	16	13	11	10	4.0
800	0.7	18	1.1	0.8	9.0	18	13	12	14	5.6
900	0.5	18	1.4	0.8	9.0	18	13	12	15	6.0
				Normal Growth Heifers and Steers						
400	1.6	12	1.4	0.8	7.0	11	16	11	7	2.8
600	1.4	16	1.5	0.9	8.5	17	15	12	10	4.0
800	1.2	19	1.5	0.9	9.5	19	13	13	11	5.6
1000	1.0	21	1.6	1.0	10.5	21	13	14	17	6.8

* *Nutrient Requirements of Beef Cattle*, Sub-Committee on Beef Cattle Nutrition, National Research Council, revised edition, 1958

rations for the same classes of cattle is shown in Table 67. If more or less gain is desired than that shown in the NRC recommendations, the T.D.N. and Digestible Energy values need to be adjusted upward or downward slightly, but this does not apply to the remaining values. Morrison's feeding standards for the same classes of cattle are shown in Table 68.

Winter Rations for Stockers. As has already been stated, the wintering of stock cattle is not likely to prove profitable unless the ration consists largely of farm-grown roughages. The presence of much grain in wintering rations is not justified. As a matter of fact, it is seldom necessary to use any grain at all for yearling cattle. Calves usually require 3 to 5 pounds of grain daily to insure satisfactory gains unless they are fed almost a full feed of corn or sorghum silage. In the absence of some kind of legume roughage, it is highly advisable to feed a high-level protein supplement to supply the protein requirements of the growing animals. Usually 1 pound of

Table 65

RECOMMENDED WINTER GAINS FOR STOCKER CATTLE
(120–150 Days)

Method of Feeding and Management the Following Summer	Calves		Yearlings		2-Year-Olds	
	Total (lb.)	ADG (lb.)	Total (lb.)	ADG (lb.)	Total (lb.)	ADG (lb.)
1. *Grazed entire summer*, sold as feeders or started on feed in *late fall (Nov.)*	115	0.75	100	0 66	50	0 33
2. Grazed until Aug 1, full-fed until late fall *or early winter (Nov.* or Dec.)	150	1.00	115	0.75	75	0.50
3. Pastured only until about *June 1; then* full-fed on pasture and marketed late fall (Nov.)	185	1 25	150	1.00	115	0.75
4. Full-fed during summer in dry lot; marketed in *early fall (Sept.)*	225	1.50	185	1.25	150	1.00
5. Full-fed during entire summer on pasture; marketed in fall (Oct.)	225	1.50	185	1.25	150	1.00

such feeds per head daily is sufficient. If 4 or more pounds of good legume hay are fed, protein concentrates may be dispensed with entirely.

The importance of supplying adequate protein in the ration of stocker cattle is clearly shown by the results of the feeding experiments summarized in Table 69. In the Nebraska experiments the addition of ½ pound of cottonseed cake to a full feed of prairie hay increased the daily gain to 0.58 pound, whereas the addition of another ½ pound of cake further increased the gain by 0.37 pound. However, 1½ pounds did not prove necessary. In the Illinois trial with calves the addition of 1 pound of protein supplement increased the daily gains by a full pound, although in the trial with yearlings, feeding 2 more pounds of clover hay increased the daily gains from 0.63 pound per steer daily to 1.16 pounds a day. A more profitable use of feed can scarcely be cited from any feeding test than that demonstrated by the protein concentrates and the additional legume hay which

Table 68

MORRISON'S FEEDING STANDARDS FOR STOCKER CATTLE*

Body Weight (lb)	Requirements per Head Daily: Dry Matter (lb.)	Digestible Protein (lb.)	Total Digestible Nutrients (lb.)	Calcium (gm)	Calcium (lb)	Phosphorus (gm)	Phosphorus (lb)	Carotene (mg)
	Growing Cattle, Fed for Rapid Growth							
300	7.2– 9.0	0.67–0.77	5.1– 6.2	18	0.040	13	0.029	20
400	9.1–11.4	0.76–0.87	6.2– 7.2	20	0.044	15	0.033	25
500	10.7–13.0	0.81–0.92	7.2– 8.4	19	0.042	15	0.033	30
600	12.4–14.7	0.84–0.95	8.1– 9.3	18	0.040	15	0.033	35
700	14.2–16.5	0.87–0.98	8.9–10.2	17	0.037	15	0.033	40
800	15.9–18.3	0.90–1.00	9.5–10.9	16	0.035	15	0.033	45
900	17.3–19.7	0.93–1.03	10.1–11.5	16	0.035	15	0.033	50
1,000	18.6–21.0	0.95–1.05	10.6–12.0	15	0.033	15	0.033	55
	Wintering Calves, to Gain 0.75 to 1.00 lb. per Head Daily							
300	7.0– 8.3	0.52–0.58	3.9– 4.6	16	0.035	12	0.026	17
400	8.7–10.3	0.63–0.70	4.8– 5.7	16	0.035	12	0.026	25
500	10.3–12.1	0.71–0.78	5.7– 6.7	16	0.035	12	0.026	30
600	11.7–13.9	0.79–0.88	6.5– 7.7	16	0.035	12	0.026	35
	Wintering Yearling Cattle, to Gain 0.50 to 0.75 lb. per Head Daily							
600	11.6–13.3	0.67–0.75	6.3– 7.2	16	0.035	12	0.026	35
700	12.9–14.8	0.76–0.83	7.0– 8.0	16	0.035	12	0.026	40
800	14.2–16.3	0.83–0.90	7.7– 8.8	16	0.035	12	0.026	45

* Taken by permission of The Morrison Publishing Co., Ithaca, N. Y., from *Feeds and Feeding*, 22nd edition, by Frank B. Morrison

Table 67

NUTRIENT REQUIREMENTS OF STOCKER CATTLE EXPRESSED AS PERCENTAGE COMPOSITION OF AIR-DRY RATIONS*

Body Weight (lb.)	Av. Daily Gain (lb.)	Daily Feed per Animal (lb.)	Requirement as Per Cent of Ration or Amount per Pound of Feed							
			Total Protein %	Digestible Protein %	Total Digest. Nutrients %	Digest. Energy (therms per lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg./lb.)	Vitamin A (I.U. per lb.)
			Wintering Weanling Calves							
400	1.0	11	10.3	6.2	55	1.10	0.26	0.20	0.6	240
500	1.0	13	10.3	6.2	54	1.08	0.22	0.17	0.7	280
600	1.0	15	9.1	5.5	53	1.05	0.19	0.15	0.7	280
			Wintering Yearling Cattle							
600	1.0	16	8.3	5.0	50	1.00	0.18	0.15	0.6	240
800	0.7	18	7.5	4.5	50	1.00	0.16	0.15	0.8	320
900	0.5	18	7.5	4.5	50	1.00	0.16	0.15	0.8	320
			Normal Growth Heifers and Steers							
400	1.6	12	11.7	7.0	58	1.16	0.29	0.21	0.6	240
600	1.4	16	9.3	5.6	53	1.06	0.20	0.16	0.6	240
800	1.2	19	7.8	4.7	50	1.00	0.17	0.15	0.7	280
1,000	1.0	21	7.8	4.7	50	1.00	0.14	0.15	0.8	320

* *Nutrient Requirements of Beef Cattle*, Sub-Committee on Beef Cattle Nutrition, National Research Council, revised edition, 1958.

Table 70

VALUE OF LOW-GRADE ROUGHAGES FOR WINTERING STOCKER CATTLE WHEN FED WITH A COMPLETE SUPPLEMENT*

	First Trial Dec. 21, 1949–Apr. 12, 1950 112 Days			Second Trial Dec. 8, 1950–May 4, 1951 147 Days		
	Oat Straw	Corn Cobs	Corn Silage	Soybean Straw	Corn Cobs	Corn Silage
Average initial wt., pounds	485	479	478	480	478	481
Average final wt.	589	671	721	595	698	806
Average total gain	104	192	243	115	220	325
Average daily gain	0 93	1 72	2 18	0 78	1.50	2 21
Average daily feed						
Roughage	12 4	12 8	31 0	13 3	13.4	37 0
Supplement A[a]	3 5	3 5	3 5	3 5	3 5	3 5
Minerals[b]	Free choice	Free choice	Free choice	0.06	0 05	0 04
Feed per hundredweight gain						
Roughage	1337	742	1423	1707	890	1671
Supplement A	377	202	160	449	233	158

* Indiana Mimeo. AH 47, 1950, and AH 59, 1951

[a] Supplement A consisted of 2.25 lb soybean oil meal, 1 lb. molasses feed, 0.18 lb. bone meal, 0 06 lb. salt, and 0 01 lb. vitamin A concentrate.

[b] Mineral mixture fed free-choice during both tests· 2 parts steamed bone meal, 1 part iodized salt, plus 1 oz. cobalt sulfate per 100 lb of salt

grass or corn silage are fed, as shown by the results of Illinois studies reported in Table 71. Had the complex supplements been fed at levels which would supply only the usually recommended level of protein concentrate, the results would not have been so overwhelmingly in favor of simple concentrates.

Roughages Used in Stocker Programs. The character of the roughage fed should depend somewhat upon the age of the cattle. Two-year-old steers can make considerable use of corn stover, cobs, and straw. Calves, on the other hand, should be fed a limited amount of such materials. If possible, corn, sorghum, or grass silage and legume hay should furnish at least 70 per cent of the dry matter of the roughage ration for calves, 50 per cent for yearlings, and 30 per cent for 2-year-old steers. The remainder may well consist of straw or other low-quality roughage.

It is highly important that the cattle be given all they will eat of some component of the ration; otherwise their hunger is not satisfied and they are restless and waste some of their energy in moving about As a matter of economy, the better practice is to limit the quantities

were fed in these wintering experiments. These tests show that calves and yearling cattle should have from ¾ to 1 pound of high-level protein supplement or 4 to 5 pounds of good legume hay daily if they are to make satisfactory gains. On the other hand, results secured at the Indiana station, reported in Table 70, in which 2 to 2 5 pounds of protein-mineral-vitamin concentrate were fed to calves wintered on corn silage, oat straw, corn cobs, and soybean straw indicate that relatively high levels of nitrogenous supplements, as well as minerals and vitamins, must be fed with low-grade roughages if the feed nutrients in such roughages are to be efficiently utilized.

Complex protein-mineral-vitamin supplements are beneficial when added to low-quality roughages as just shown. However, such supplements are not required when such good-quality roughages as legume-

Table 69

IMPORTANCE OF ADEQUATE PROTEIN IN THE RATIONS OF STOCKER CATTLE

Nebraska Bulletin 357

Concentrate Fed	None	0.5 lb. Cotton-seed Cake	0.75 lb Cotton-seed Cake	1.0 lb. Cotton-seed Cake	1.5 lb. Cotton-seed Cake
Number of trials averaged	5	2	3	3	2
Average initial weight, lb	408	418	433	385	363
Average final weight, lb.	433	543	596	564	548
Average winter gain, lb.	25	125	163	179	185
Average daily gain, lb.	0.15	0.73	0.92	1.10	1.16
Average prairie hay eaten daily, lb.	10.6	12.7	13.7	13.2	11.6
Average summer gain, lb.	259	231	222	212	190
Average total gain, lb.	284	356	385	391	375

Illinois Mimeographed Reports

	Calves (1942–1943) First Period	Calves (1942–1943) Second Period	Yearling Steers (1946–1947) First Period	Yearling Steers (1946–1947) Second Period
Average initial weight, lb.	471	567	682	729
Days in period	140	20	70	105
Average daily ration:				
Corn silage, lb.	18.1	21.9	30.0	30.0
Protein concentrate, lb	—	1.0	—	—
Legume hay, lb.	3.7	3.8	3 0	5.0
Average daily gain, lb.	0 68	1.75	0.68	1.16

eaten, since the major portion of their ration is made up of such feeds. Various methods of improving the palatability of these roughages have been tried, chief among which are cutting or chafing straw and shredding or grinding stover. Pelleting holds much promise, whereas the addition of molasses is an accepted practice in larger operations.

Corn and Sorghum Silage. Silage is the most satisfactory feed for wintering stocker cattle. Experiments such as those reported in Table 72 amply prove this. The palatability of silage insures a sufficient consumption of feed to produce good growth and development. Its succulent nature makes it a good substitute for grass and thus keeps the digestive system in a healthy condition. It is usually sufficiently cheap to permit liberal feeding without unduly increasing the cost of wintering. In fact, when yield per acre, ease of feeding,

Table 72

Silage vs. Dry Roughages for Wintering Stocker Cattle

	Illinois Bulletin 73, 1902		Missouri Mimeo Report, 1933–1934		Nebraska Mimeo Report 134, 1932 (3 year av.)			Kansas (Ft. Hays Report), 1926		Illinois Report, 1938–1939	
	Corn Silage Mix. *Hay* Oats	Shock Corn Mix. *Hay* Oats	Shock Corn *Alfalfa*	Alfalfa Hay	Corn Silage *Alfalfa*	Shelled Corn *Alfalfa*	Ground Shock Corn Alfalfa	Cane Silage C S M	Cane Fodder C.S.M	Corn *Silage*	Alfalfa *Hay*
Av. initial wt., lb.	504	492	400	402	381	381	377	794	803	424	427
Days fed .	88	88	140	140	143	143	143	90	90	150	150
Av. daily ration											
Silage or fodder. . .	26.1	13.2	7.8		32.4		14.0	67.3	31.9	18.9	
Hay .	4.0	4.0	5.0	11.4	2.4	10.6	2.4			3.0	11.0
Straw (straw fed to only one lot)											2.0
Concentrate	2.0	2.0				3.0		2.0	2.0	1.0	
Av. daily gain	1.68	1.42	.99	.81	1.55	1.43	1.53	2.08	1.41	1.22	.93
Gain per acre of corn (or cane)	992	385			541		473	606	309	1619	[illegible]*
Steer days per acre of corn (or cane)	590	413			310		282	791	220	1212	634*

* Per acre of alfalfa hay 3½ tons per acre

Table 71

COMPARISON OF SIMPLE AND COMPLEX SUPPLEMENTS FOR GOOD QUALITY ROUGHAGES FED TO STOCKER CALVES*

Type of Silage	*Corn Silage*		*Legume-Grass Silage*†	
Supplement Fed	Purdue Suppl. A	Soybean Meal Ground Shelled Corn	Purdue Suppl. A	Ground Shelled Corn
Days fed	125	125	160	160
Average initial weight, lb	333	320	400	400
Average daily gain, lb	2.19	2.17	1.51	1.65
Average daily ration, lb.				
Silage	27.5	26.6	22.5	22.5
Protein sup	3.5	1.25	3.5	—
Ground shelled corn	—	2.00	—	3.5
Minerals	0.08	0.11	0.06	0 07
Feed cost per cwt. gain ($)	15.31	12.74	21.58	14 05
Winter feed bill per head ($)	42.09	34 61	49.85	36.95

* Illinois Cattle Feeders Day Reports, 1952 and 1953.
† Contained 150 lb. of ground shelled corn preservative per ton of silage.

of legume hay and silage to the amounts actually required to produce the desired gains, and supply a cheaper feed such as cottonseed hulls or straw before the cattle at all times. Stocker cattle consume the equivalent of approximately 2.5 per cent of their live weight daily, in total air-dry ration, if they are in average flesh. Thin stockers may consume slightly more and, conversely, fleshier stockers consume less.

Although stovers and the straws of grain crops are excellent roughages in combination with more nutritious feeds for wintering stockers, young cattle should not be expected to thrive on such feeds alone. Not only are these feeds quite deficient in protein, but they are so coarse and unpalatable that the quantities eaten often do little more than meet maintenance requirements and leave insufficient nutrients and energy to promote proper growth.

It sometimes happens that trouble is experienced in getting even older cattle to consume the desired quantities of the lower grades of roughage For them it is highly important that large quantities be

Table 73

EFFECT OF A SMALL HAY ADDITION TO A SILAGE STOCKER RATION FED TO CALVES*

Roughages Fed	Steer Calves (133 Days) Legume-Grass Silage	Legume-Grass Silage + Hay
Number of calves	10	10
Initial weight, lb.	435	435
Average daily gain, lb.	1.68	1.80
Average daily ration, lb.		
Silage	28.7	22 8
Hay	—	2.2
Ground shelled corn	3.5	3.5
Mineral mixture	0.07	0 07
Feed cost per cwt. gain ($)	13 26	12.45

* Illinois Cattle Feeders Day Report, 1954.

results from well controlled tests but the reader should be cautioned that varietal changes, variation in methods of making and feeding silage, fertilizer treatments, and even class and breeding of stocker cattle to which the silage is fed can all be responsible for results that might be far different from those reported in these and other tables.

Table 74

A COMPARISON OF DIFFERENT SILAGES FOR YEARLING STOCKER STEERS*

	Corn Silage	Legume Silage†	Sorgo Silage	Barley Silage
Percentage of moisture when fed	63.7	74.1	72.9	77.5
Percentage of protein	3 0	4 4	2.1	2 7
Yield per acre, tons	8 5–9 0	.	15.0	.
Preservative added, pounds	None	78	None	45
Initial weight of cattle, pounds	738 8	739.7	738 8	739.9
Average daily gain, 126 days	1.85	1.34	1.21	1.00
Average daily ration				
Silage	32.1	38.1	35.1	40.2
Alfalfa hay	6.6	6.7	6 6	6.8
Feed eaten per cwt. gain				
Silage	1,734	2,834	2,890	4,012
Alfalfa hay	357	497	547	679

* Missouri Mimeo Report, June 1, 1942.

† The legume silage was made from a mixed seeding of alfalfa, sweet clover, and red clover, which was siloed the last week of May.

and the amount required to produce a given gain are considered, corn and sorghum silages are usually the cheapest feeds that can be fed to young stocker cattle.

Weanling calves should be fed as much silage as they will consume, which averages approximately 30 pounds a day if they are fed only a little hay. Older cattle, if fed silage according to appetite, are likely to lay on too much fat to make the most efficient use of grass the following spring. Hence the silage should be limited to 3 or 4 pounds per hundredweight and additional roughage supplied in the form of hay and straw Corn and sorghum silages are low in both protein and minerals Therefore approximately 1 pound of protein supplement and $\frac{1}{10}$ pound of finely ground limestone or dicalcium phosphate should be fed daily per head unless 4 or more pounds of leafy legume hay are present in the ration.

Legume-Grass Silage. Silage made from mixed grasses and legumes cut at the proper stage of maturity and carefully siloed is an excellent feed for stocker cattle. Such silage has a high protein content and does not need to be supplemented with a protein concentrate. However, it is much lower in energy than corn silage, and smaller gains result from its use, unless grain is added to it as preservative, at the rate of 150 to 200 pounds a ton, or unless it is supplemented with some grain when fed to cattle. If both corn silage and legume-grass silage are to be fed to a drove of cattle during the winter, the legume-grass silage should be fed out first, since it usually is less palatable than corn silage.

The addition of a low level of a dry roughage to a heavy feed of silage being fed to stockers is recommended. Although the cause for the beneficial responses obtained from such additions is not well established, the physiological well-being of both the rumen microorganisms and the host animal are apparently involved. Table 73 shows the results of one of several such trials conducted in recent years. In this trial, dry matter intake was constant and the small amount of hay fed was comparable to the silage replaced with respect to species and stage of maturity when cut.

Comparison of Different Silages. It must be recognized that quality of silage can vary tremendously and differences in the feeding value between two samples of legume-grass silage, for instance, may well be greater than between the silages made from two different crop species Drawing conclusions from a single year's use of a particular kind of silage or from an experiment conducted for only one year at only one experiment station may possibly lead to over-enthusiasm followed by disappointment and failure. Table 74 and Figure 59 show

because good hay-curing days are few in most parts of the country, especially for the first cutting. Energy supplementation of mixed-hay stocker rations is required, as it is with legume-grass silages, with 2 to 4 pounds of grain daily being the level usually fed. Protein supplementation may or may not be required, depending upon the quality of the roughage. As a general rule, if the hay consumed daily contains the equivalent of 4 pounds of good quality legume hay, supplementation with a protein concentrate increases gains, but no more than if a similar amount of a high-energy concentrate such as corn or ground grain sorghum is added. Carotene or vitamin A, calcium, and phosphorus supplements may be needed in very poor quality mixed-hay rations

Grass Hay. Straight grass hays such as prairie hay, timothy, Sudan or Johnson grass, may satisfactorily make up a major portion of the ration of stocker cattle, but fairly complete supplementation with protein, minerals, and vitamins is essential for normal growth. Added energy supplementation is needed if any improvement in condition is desired. Such supplementation is even more essential (in larger amounts) for rations composed largely of such low-quality roughages as ground corn cobs, cottonseed hulls, cereal straws, corn and sorghum stovers, and gin trash. The use of blackstrap molasses or supplements containing molasses increases consumption of these latter roughages and is thus almost essential.

Stalk Fields. Stalk fields furnish much cheap feed for stocker cattle during the late fall and early winter. Many Corn Belt feeders, as well as those in the grain sorghum belt, follow the practice of buying their feeder cattle, especially yearlings, in October or November and running them on stubble and stalk fields until about the first of January, when they are put into the feed lot and started on corn. Yearlings are better than calves for this method of handling, inasmuch as they are better able to make use of the coarse roughage that stalk fields furnish. Stocker cattle, particularly calves, should never be maintained wholly on stalks because stalks are very low in net energy and very deficient in protein. Unless there is access to a good bluegrass or clover pasture or winter small grains, cattle on stalk fields should be fed 4 to 6 pounds of legume hay or 1 to 1½ pounds of protein concentrate per head daily.

Concentrates for Stocker Cattle. Whether or not stocker cattle should be fed concentrates during the winter depends upon the amount and character of roughage fed and upon the plan of feeding to be followed during the coming summer As a rule yearling cattle require no concentrates other than a pound of protein supplement, and even

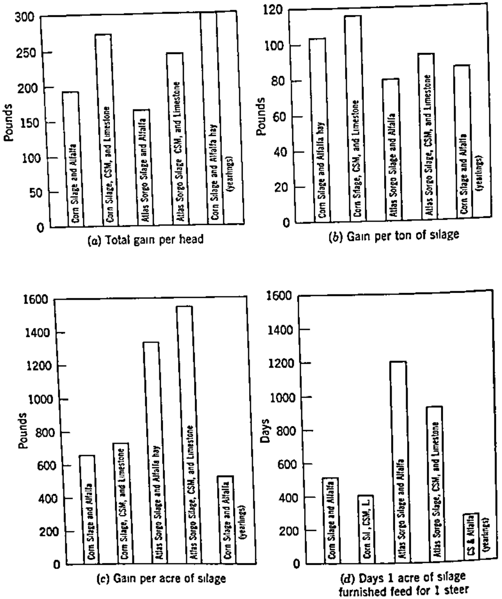

FIG. 59. Important factors to consider in selecting stocker rations. The gain made per head and per acre the following summer are further important factors. (Nebraska Mimeograph Cattle Circular 146.)

Legume-Grass Hay. Mixed hays containing up to 50 per cent legumes such as alfalfa, red clover, or lespedeza are excellent feed for stocker cattle, especially if the hays are cut before they are unduly mature and fibrous, and if they are properly cured. In all but the western sections of the country, such hays are all too often lower in quality than the same crops preserved as silage. This inferiority is

Table 76

RECOMMENDED WINTER RATIONS FOR STOCKER CATTLE

	Rations	Calves (lb.)	Yearlings (lb.)	2-Year-Olds (lb.)
I.	Alfalfa or clover hay	5–6	4–5	4–5
	Corn or sorghum silage	25	15	20
	Oat straw*	..	8–10	12–14
II.	Clover hay	8–10	6–8	4–5
	Corn or oats	3–4	..	..
	Straw or stover	2–4	12–15	16–20
III.	Soybean, cottonseed, or linseed oil meal	1–1.5	1.0	1.0
	Corn or sorghum silage	20–25	20	25
	Straw or stover	2–3	10–12	14–16
IV.	Grass hay	10–12	16–20	18–22
	Corn, sorghum, or oats	2–3	1–2	.
	Soybean, cottonseed, or linseed oil meal	1–1.5	1–1.5	1–1.5
V.	Legume-grass or oat silage	20–25	35–45	40–50
	Corn, sorghum, or oats	2–4	1–2	
	Straw or mixed hay	2	2	2
	Expected gain	1.0–1.5	0.75–1.25	0.50–1.00

* All straw and stover should be fed according to appetite.

to furnish as much protein as is present in 1 pound of the oilseed meals. Experiments carried on at the Kansas station indicate that 2 pounds of ground barley or wheat, 3 pounds of wheat bran, or 4 pounds of alfalfa hay are as good supplements to a full feed of silage as 1 pound of linseed, cottonseed, or soybean oil meal.[3]

Recommended Winter Rations for Stocker Cattle. Stocker cattle are being successfully fed on a wide variety of rations and it speaks well for this program that it can be adapted to the efficient utilization of so many different roughages. Some recommended rations, based on the more commonly used roughages and concentrates, are found in Table 76.

Summer Management of Young Cattle. The problems of managing stockers during the summer are simple in comparison with those arising during the winter. With the arrival of spring pasture, feeding problems are largely solved, inasmuch as good pasture is an ideal ration for young growing animals. It not only is nutritious and rich

[3] Kansas, Fort Hays Branch, Reports, 1932, 1933, 1937, 1938.

this is not needed if 4 or more pounds of legume hay are fed daily. Calves that are not fed silage should be fed 2 to 4 pounds of grain daily, since they are unable to consume enough dry roughage to gain more than a pound a day, which is less gain than that representing normal growth and development. However, calves that are fed a full feed of good corn silage and 1 pound of a protein concentrate or 4 or 5 pounds of legume hay need not be fed grain during the winter unless they are to be marketed after only a short feed the following summer and fall. Then the feeding of some grain during the winter is advisable, because the cattle have a higher finish and sell for a better price when they are marketed. The effect of such low-level grain additions is shown in Table 75.

Except in the case of poor- to very poor-quality roughages there is apparently little difference between the various protein concentrates for feeding stocker cattle, provided they are fed in sufficient amounts

Table 75

The Effect of Feeding During the Winter a Half Ration of Grain to Calves Which Are to be Grazed the Following Summer

	Missouri Exp. Station* Av. of 3 trials		Kansas Exp Station* Av. of 3 trials	
	Grain and Roughage	Roughage Only	Grain and Roughage	Roughage Only
Av. initial weight, lbs.	342	348	350	349
Av. *winter ration*				
Sh. corn, lbs.	3.8	...	4.6	...
Protein concentrate	5	...	1.0	1.0
Corn or cane silage	11.2	14.3	18.4	24.0
Legume hay	4.2	4.5	2.0	2.0
Av. daily gain	1.70	.88	1.89	1.34
Grazed without grain	56 days	56 days	90 days	90 days
Total gain on pasture, lbs.	22	57	98	123
Av. daily gain on pasture	.34	1.02	1.09	1.38
Full fed grain on pasture	112 days	112 days	100 days	100 days
Total gain, lbs.	269	276	256	263
Av. daily gain	2 41	2.47	2.56	2.63
Final weight	912	823	961	917
Market value per cwt.	$14.17	$13.75	$14.92	$14.58
Shelled corn fed, bu.	36.5	24.3	36.9	26.2

*Mimeographed Reports of Cattle-feeding Experiments.

in growth-producing and protective vitamins, and fairly well balanced as to those compounds needed for the building of bone and muscle, but its succulent nature makes for the health and thrift that normally accompany a well-regulated digestive tract. Pastures to be used by young breeding animals should not be heavily stocked unless there are adequate facilities for feeding harvested feeds if the supply of grass becomes short.

Grass alone ordinarily provides a satisfactory ration for growing cattle during the lush growing season. With stocker steers or grade yearling heifers intended for a commercial breeding herd, economy of maintenance usually requires that pasture alone, if it is available, should form the ration for the entire summer, even though the cattle lose some flesh and are slowed up somewhat in rate of growth. If the grass fails because of dry weather, pastures should be supplemented by feeding silage, hay, or green corn, as illustrated in Figure 61.

Summer Gains of Young Cattle on Pasture. The gains made during the summer by young cattle on pasture do, of course, vary greatly with the condition of the animals at the beginning of the grazing season and with the kind of forage provided. Also, they vary from year to year because of weather conditions, which greatly affect the amount and palatability of the forage. Occasionally a severe drought and the discomfort caused by flies and oppressive heat may result in a loss during midsummer of a considerable amount of the gain put on during the spring. As a consequence, the gain for the entire season is disappointingly small. However, such years are in the course of time offset by unusually favorable seasons, when the gains made are almost double those obtained during an average year.

Yearling cattle weighing approximately 550 to 650 pounds when turned onto pasture gain at the rate of 1¼ to 1½ pounds a day—or 200 to 250 pounds for the season—on good permanent pasture such as bluegrass, brome grass, or the bluestem pastures of Kansas. Two-year-olds gain 50 to 75 pounds more if the forage is sufficiently abundant and nutritious to cause a noticeable improvement in degree of flesh, but they gain 50 to 75 pounds less if the forage provides for only growth requirements. Rotation pastures that consist largely of legumes and hence retain their freshness and palatability throughout the summer may usually be counted on for about 50 per cent more gain per head than is obtained from permanent pastures during the same season. The gain made by young cattle on pasture is treated in more detail in Chapter 22

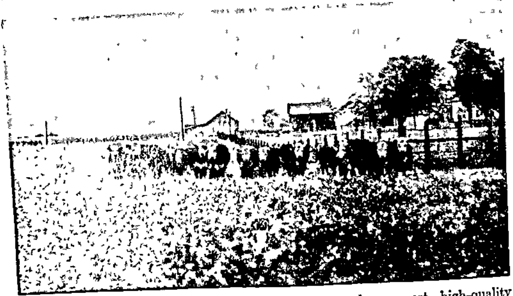

FIG. 60. Yearling stocker steers can advantageously convert high-quality legume-grass rotation pastures to gains without the use of grain. Monthly gains of 75 to 100 pounds per acre may be expected during the peak pasture months. (University of Illinois.)

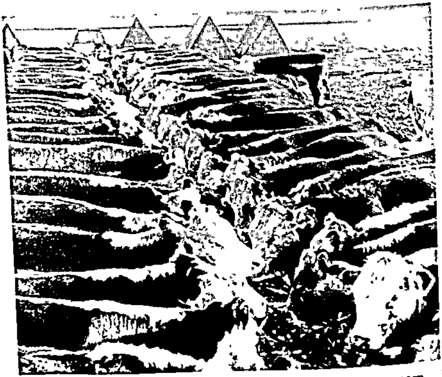

FIG. 61. Newly received yearling heifers on well-eared green corn. Upon supplementation with a fortified protein-mineral supplement, corn harvested in this manner has produced a ton of gain per acre. (Prairie Farmer.)

Table 77 illustrates differences in gains of stockers on pasture as affected by winter ration and by area of the country. The slow gains made by 2- and 3-year-olds, both on winter rations and on pasture, further demonstrate the impracticability of the stocker program for cattle of such ages.

Table 77

DEVELOPMENT OF STOCKER CATTLE FROM WEANLING CALVES TO THREE-YEAR-OLD STEERS WHERE LOW FEED COSTS ARE EMPHASIZED RATHER THAN NORMAL GROWTH AND DEVELOPMENT

	West Virginia Bulletin 218			Kansas Circular 97	
Winter Ration	Clover Hay Corn Silage Wheat Straw	C. S. Meal Corn Silage Wheat Straw	Mixed Hay Grain Mixture*	Corn Silage C. S. Meal	Alfalfa Hay
1st winter as calves, days	124	124	124	134	134
Av. daily ration, lb.					
Hay	3.2	....	10.0	....	10.3
Silage	12 3	12.3	....	25.0	....
Straw	1 0	3 3	....	....	...
Concentrate		7	3.0	1.0	....
Av. daily gain	.47	.64	.91	.72	.45
1st summer on pasture, days	236	236	236	210	210
Av. daily gain	54	.50	.42	1.32	1.44
2nd winter as yearlings, days	120	120	120	161	161
Av daily ration, lb.					
Hay	5 0	...	5.0	....	20 2
Silage	18 0	18 0	18.0	35.8	....
Straw	2 0	5 0	2.0	....	....
Concentrate		1 0	....	1.0	...
Av daily gain	73	66	.33	.97	.47
2nd summer on pasture, days	241	241	241	210	210
Av daily gain	98	1 08	1.18	.68	1 14
3rd winter as 2-year-olds, days		126		150	150
Av. daily ration, lb					
Hay		...		...	21.6
Silage		26.0		35.0	...
Straw		4.8		..	..
Concentrate		1 1		1.4	...
Av daily gain		28		13	.25
3rd summer on pasture, days		141			
Av daily gain		2 26			
Av final weight		1,250			
Total days on stocker rations		988		865	865
Av total gain		872		693	716
Av daily gain		.88		.80	.83

* Grain mixture consisted of 3 parts of corn, 1 of bran, and 1 of linseed meal

Table 78

NUMBER OF CATTLE AND CALVES ON FEED, BY IMPORTANT STATES*

State	Rank 1957	Number on Feed 1930–34 (1,000 head)	Number on Feed 1957 (1,000 head)	Percentage of Total 1930–34 (%)	Percentage of Total 1957 (%)	Percentage Increase 1930–34 to 1957 (%)
Iowa	1	605	1,295	20.2	21.2	114
Nebr.	3	402	560	13.4	9.2	39
Minn.	5	212	371	7.1	6.1	75
Mo.	7	237	281	7.9	4.6	19
S. Dak.	10	115	210	3 8	3.4	83
Kans.	12	273	162	9.1	2.7	– 41
West North Central		1,874†	2,977	62.5	48.8	59
Ill.	2	324	690	10 8	11.3	113
Ind.	6	87	321	3.9	5.3	269
Ohio	11	93	200	3 1	3 3	115
Mich.	14	66	124	2.2	2.0	88
East North Central		617	1,448	20.6	23.7	135
Calif	4	64	496	2.1	8 2	675
Colo.	8	105	246	3.5	4 0	134
Ariz.	9	37	222	1.2	3.6	500
Texas	13	87	143	2.9	2.3	64
Idaho	15	26	121	.9	2 0	365
Western		453	1,584	15.1	26 0	250
United States		2,997	6,099	100 0	100 0	104

* U.S.D.A. *Economic Trends in Cattle Feeding,* courtesy H. F. Breimyer

† Only important cattle-producing states are included in regional totals.

Advantages and Disadvantages of the Cattle Finishing Program. The cattle finishing program is one which offers much opportunity for profit, but at the same time it is one which results in as many failures, financially speaking, as all the other beef cattle programs combined The principal reasons for failure are that (1) feeds used in finishing rations are relatively expensive; (2) feed conversion is less efficient for finishing purposes than for growth; and (3) price fluctuations may erase "price spread," one of the sources of profit. Very economical gains in the stocker program or very cheap maintenance rations in the cow-calf program can often offset mistakes in judgment at buying and selling time, but no such opportunity presents itself in the finishing program. Sometimes when both stocker and finishing programs are carried out successively on the same farm, all the money made in the

chapter **12**

FINISHING CATTLE FOR MARKET

The finishing of cattle for market is one of the most important phases of the American agricultural economy. Although it is carried on most extensively in the Corn Belt or North Central States, it is by no means confined to that area. Cattle feeding is becoming more and more important in the Pacific Coast states and in the South and Southwest with the passing of each year. The inherent tendency of beef cattle to lay on fat, or finish, whenever they have the opportunity to consume more nutrients than are needed for growth and maintenance makes the finishing of cattle well suited to any area that produces an abundance of grain, high-quality roughages, and good pastures.

Both Table 78 and Figure 62 illustrate that the western states and the east North Central States have seen large increases in the cattle finishing business. Much, if not all, of the increase in the West can be accounted for by the increase in commercial feed yard finishing.

Reasons for Feeding Cattle. Cattle are usually fed for one or more of the following reasons: (1) to obtain better than current prices for farm-grown grains; (2) to market roughages and pasture at a profit; and (3) to maintain and improve the fertility of the soil. These reasons may be combined by saying that cattle are fed to obtain the highest net return for farm-grown feeds. This statement implies that cattle are finished principally on feeds grown on the farm where the cattle are fed. This statement is largely true, although there are a few large feeders and feed yard operators who buy most or nearly all of their feeds and who may even lease the ground on which their feed lots are located. Such men feed cattle for the same reason that other men operate factories; namely, to make a profit by combining raw materials, which are of low value in their natural form, into a product for which there is a strong demand and which, therefore, can be sold for a much higher price than the cost of the raw materials.

Even when the cattle finishing program is the obvious choice for best utilization of the pastures, harvested roughages, and grains found on a farm, certain disadvantages are inherent in this program and should be recognized:

1. The program is speculative, with the result that large amounts of money are sometimes lost. As will be shown later, some finishing programs are less risky than others.

2. Skilled buying and selling are required. This accounts for such common sayings as "well bought is half sold" with reference to feeder cattle.

3. Relatively large amounts of capital must be in hand, or readily available, to make the necessary periodic purchases of feeder cattle.

4. Specialized feedlot and feed preparation equipment is required.

5. Feeding skill is necessary in the finishing program, especially in the early stages while the feeder cattle are being brought to a full feed of concentrates.

6. Serious labor conflicts may develop, especially with summer finishing programs.

7. The program, requiring rather constant attention, is rather confining, although push-button feeding systems minimize such confinement. The program may interfere with weekend absences and long vacations.

Sources of Profit. A discussion of profits that might be expected from a cattle feeding enterprise must include a breakdown of the following two sources of potential profit:

1. Price spread—the difference between buying and selling price per 100 pounds. Price spread is also sometimes simply referred to as "margin" and is not to be confused with "feeding margin." It is applied to the purchased weight only.

2. Feeding margin—the difference between the cost of producing 100 pounds of gain and the selling price per hundredweight. Feeding margin applies only to the weight added during feeding.

The following example illustrates how these two factors function:

(1) Price spread
400 lb. calf purchased @ \$20 cwt. delivered.
1,100 lb. choice steer sold @ \$24 cwt. net.
\$24 − \$20 (4.0 cwt.) = \$16 potential profit due to price spread

(2) Feeding margin
1,100 lb. − 400 lb. = 700 lb. gain @ cost of \$21 cwt. gain
\$24 − \$21 (7.0 cwt.) = \$21 potential profit due to feeding margin
\$16 + \$21 = \$37 total returns above cost of feed and feeder steer calf.

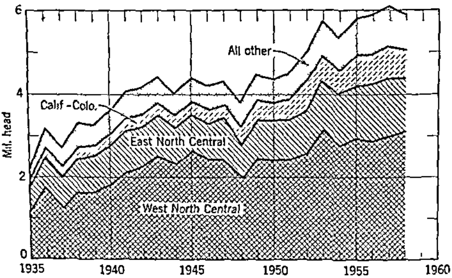

FIG. 62. Cattle on feed January 1, 1958, by principal cattle-feeding regions. Feeders in the West North Central region still feed over half of the grain-fed cattle annually produced in the United States but other regions are increasing their numbers at a faster rate. (U.S.D.A.)

stocker program and more, is lost in the finishing program because of poor planning or a disastrous decline in prices. For this and many other reasons, a thorough understanding of this, the riskiest of all the commercial cattle programs, is essential. The very large number of participants in this program is evidence of the following advantages usually ascribed to the finishing program:

1. The program, because of its intensive nature, affords an opportunity to market at a profit large quantities of both roughages and farm-grown grains.

2. Large profits are occasionally made with this program due to favorable price rises during the period of ownership of a drove of feeder cattle.

3. A large volume of high fertility-value manure is produced in this program.

4. It is a relatively short-time program, making it possible to turn more than one drove of cattle per year in some types of finishing programs, or to finish off a drove of cattle between peak labor requirements in farming operations.

5. The program is flexible with respect to number, weight, and grade of cattle, as well as to length of feeding period and type of ration fed.

6. Death losses are relatively low as compared with some of the other programs such as the cow-calf program.

Table 79

NET RETURN PER HEAD DUE TO PRICE SPREAD AND FEEDING MARGIN IN SIX CORN BELT PROGRAMS*

(Average 1948–52, 1953–54, 1954–55)

Feeding Program	1948–49 to 1952–53 Average: From Price Spread† ($)	From Feeding Margin‡ ($)	Total Net Return§ ($)	Feeding Season 1953–54: From Price Spread† ($)	From Feeding Margin‡ ($)	Total Net Return§ ($)	1954–55: From Price Spread† ($)	From Feeding Margin‡ ($)	Total Net Return§ ($)
Calves									
Heifer calves, short fed	2.41	27.92	30.33	30.79	−1.10	29 69	17.11	0.29	17.40
Steer calves, long fed	0 56	46 00	46 56	26.72	13 68	40 40	4 63	8.80	13.43
Yearlings									
Medium steers, short fed	15.47	−6.12	9.35	49.16	−16 04	33.12	36 03	−13 89	22.14
Good steers, short fed	13 53	6.42	19.95	49.94	−13.22	36.72	24.98	−12 05	12.93
Good and choice steers, long fed	22.22	23 96	46.18	52.48	−4 85	47.63	17.90	−9.87	8 09
Heavy steers									
Good heavy steers, short fed	33 31	−4.55	28.76	76 94	−19.96	56.98	57.22	−15 05	42.17

* Fifteenth Annual Report of Feeder Cattle, Department of Agricultural Economics, University of Illinois, 1954.

† Gain (or loss) in value from the higher (or lower) price per 100 pounds received for the fed steer than paid for the feeder. Calculated on initial weight of feeder. Transportation and marketing expenses deducted.

‡ Difference between value of weight put on feeder, as calculated at selling price of fed steer (corrected for marketing expense), and cost of feed fed.

§ Calculated without allowance for costs of labor, overhead or death loss, or for credits for manure or gain on hogs following steers.

After paying for the feeder steer, feed, and buying and marketing costs, a total of $37 potential profit remains out of which must be deducted the following additional costs: labor, interest on investment in steers, equipment and buildings, depreciation on machinery, equipment, and buildings, death loss, veterinary costs, and insurance. Many cattle feeders lump all of these incidental costs together and hope the price spread takes care of these items.

When portions of the dry lot rations or the pasture are of such low quality that they have no sale value, many cattle feeders simply do not charge the cattle with these feeds, since they would not otherwise have been used. Examples are cornstalk fields, meadow aftermath, or permanent pasture which cannot be harvested for hay.

In some years steers are fed on a minus price spread; that is, the cattle sell for less per hundredweight than their cost. This situation puts the entire burden for profit on the feeding margin. The relative importance of the two sources of potential profit depends upon the age, weight, sex, and grade of the feeder cattle, the price of feed, and the relationship between the selling price of cattle and the cost or value of feed and other items which contribute to the total cost of gains. These relationships will be discussed further in Chapters 13 and 14.

Table 79 gives some comparisons which illustrate that net returns due to favorable price spreads are generally smaller and proportionately less of the total return for the calf programs than for those programs in which older or heavier cattle are used. The table also shows that the older and heavier feeder cattle programs produce less net return from the feeding margin. This result is merely a reflection of the principle that older cattle convert feeds to gain less efficiently than calves

Methods of Finishing Cattle. A wide variety of programs are used in finishing cattle for market. Although there is no best method, even for a particular feeding situation, some methods are more likely to prove satisfactory than others when certain conditions prevail.

Successful feeders choose the single program, or combination of programs, that best fits their needs, and they change only when it is necessary to adjust to changing needs. Under some conditions a combination of two or more programs offers some special advantages, especially on larger farms Among the factors that should be given consideration in determining the method of feeding to be used are the following:

1. *Length of feeding period.* Usually cattle that are fed grain or concentrates for less than 120 days are called "short-fed cattle." Ordi-

Limited feeding is usually practiced either during a wintering or grazing period in which principally growth, rather than fattening, is desired, or when a heavy feed of roughages plus some concentrates is fed just prior to a period of full feeding. The latter is done in order to cheapen the gains made during the entire feeding program. Roughages and pastures, when adequately supplemented, make cheap gains but often these feeds, when unsupplemented, scarcely do more than maintain the weight of cattle. This fact accounts for the practice of limited feeding of supplemental high-energy concentrates.

3. *Methods of feeding.* Cattle may be fed finishing rations in dry lot or on pasture, or both. For example, many cattle, especially calves, are first wintered on a ration consisting almost entirely of roughage plus, at most, a limited grain feed. They are then fed either a limited feed or a full feed of grain on pasture during spring and summer, after which they are finally finished in dry lot on a full feed for about 60 days. This combination of programs furnishes a market for harvested roughages and grains as well as pasture, which in the final analysis is one of the primary reasons for feeding cattle.

4. *Time of year when fed.* For the most part, cattle finished principally in dry lot are fed during the winter months, whereas those finished on pasture are naturally fed in the non-winter months or during the pasture-growing season. Most specialized feed yard operators feed cattle in dry lot on a year-round basis.

The Kind of Cattle to Feed. Most systems of feeding require a certain kind of cattle if the cattle are to be most successful. Conversely, each type of cattle should be fed according to a rather well-recognized plan if the most profit is to be returned. During a period when prices are rising and profits are large, a particular drove of cattle may return a profit almost regardless of the way they are fed, but when the reverse is true, the kind of cattle purchased must be well suited to the plan of feeding if a profit is to be made.

Feeder cattle vary widely in those characteristics which affect their suitability for different feeding conditions and which, therefore, are important to prospective buyers. Their chief differences are as follows:

1. Age: calves, yearlings, and 2-year-olds.
2. Condition: thin, medium, and fleshy.
3. Weight: light, medium, and heavy. Weight, of course, is the result of both age and condition. For example, a calf 9 months old in fleshy condition may weigh as much as or more than a very thin yearling.

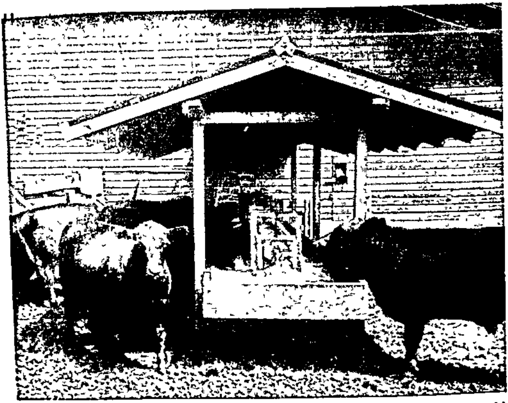

FIG. 63. Long-fed cattle such as these near-prime steers assume considerable importance in a few Corn Belt areas but, generally speaking, choice is the grade of preference of most cattle feeders. (Corn Belt Farm Dailies.)

narily, less than 25 bushels of corn or similar concentrate are fed per head to such cattle. On the other hand, if cattle are fed finishing rations for 8 to 10 months they are spoken of as "long-fed cattle." These cattle (usually yearling or 2-year-old steers) ordinarily grade prime provided they were of sufficiently good breeding. They have consumed 75 bushels or more of corn or similar feeds per head. Anything falling about midway between these limits is regarded as a medium feeding period.

2. *Relative amount of grain or concentrates in the ration.* This amount may vary from a "full feed" of concentrates (1.5 to 2.0 pounds for each 100 pounds of body weight daily) to a "limited feed" (2 to 8 pounds per head per day). Cattle are full-fed in order to finish them quickly. It may not be the most economical way to produce a pound of gain, but feeders follow this practice in order to insure that there will be sufficient finish on the cattle to make them meet market demands and, of course, to market their grain. Full feeding usually follows a period of feeding on growing rations or a period of grazing.

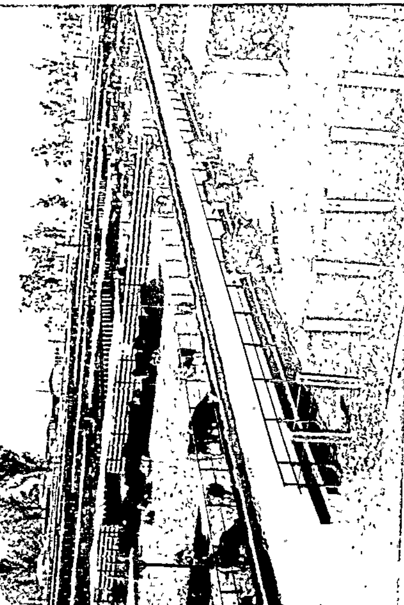

FIG. 64. Commercial feed yards such as this one in California are responsible for most of the increase in numbers of cattle fed in the West and Southwest. A short feed of 120-150 days will finish feeders of this grade. Note high shades, fenceline bunks, rocked driveway, and feed-processing plant. (National Cottonseed Products Association, Inc.)

4. Sex: steers, heifers, and cows. Steers may be of any age from 4 to 40 months, but feeding heifers are seldom older than 24 months. If older, they probably have produced a calf, after which time they are called heiferettes.

5. Breeding: beef, mixed, and dairy. Cattle are said to show beef breeding when they show the characteristics of the Angus, Hereford, Shorthorn, or Brahman breeds. A drove of cattle of mixed breeding usually contains at least some animals that have both beef and dairy ancestry.

6. Grade: fancy, choice, good, medium, and common. As discussed in Chapter 11, the grade of an animal indicates its all-around desirability for the use to which it will be put—in the case of a feeder steer, its desirability for feeding. The grade of a feeder steer or heifer is determined chiefly by its type, quality, and breeding.

7. Origin: Some cattle feeders attach importance to the region from which the cattle have been shipped. Cattle from certain areas in Texas and New Mexico are very popular with certain Corn Belt feeders. Others maintain that such cattle lack the hardiness possessed by those bred and raised farther north. However, it seems highly doubtful if any preference should be shown for a drove of cattle solely because they have come from a certain area. Every important cattle-breeding area of the country produces some excellent cattle and some that are only mediocre. Each drove should be judged on its own merit and not on that of another shipment from the same locality.

Contract Feeding. Occasionally a large rancher, packer, or cattle speculator enters into a contract with a cattle feeder to fatten cattle without a change of ownership. Usually the feeder agrees to feed the cattle a certain ration for a specified time for a stated charge per hundred for a minimum gain of 200 to 350 pounds a head. For all gains over this minimum he receives a considerably larger amount per hundred pounds. Death losses, if any, are usually shared by the owner to the extent of the average weight of the drove into the feed lot, which means that the feeder bears the loss of the feed eaten by the steers that died. Gains made by hogs kept in the feed lot and manure produced by the cattle usually belong to the feeder, sometimes as payment for his labor and sometimes as rental for the feed lots, buildings, and equipment used.

Contract feeding has never been popular in the Corn Belt because seldom have both parties been satisfied with the results of the arrangement. If prices are rising and the cattle return the owner a handsome profit, the feeder is unhappy that he does not own the cattle himself

Table 80

SELECTED CHARACTERISTICS OF SAMPLED FEED YARDS, GROUPED BY NUMBER OF HEAD FED*

Characteristic	Group I	Group II	Group III	Group IV
Range in number of head fed during year	below 1,900	1,900–4,799	4,800–12,999	13,000 and up
Average number of head fed during year	866	2,696	8,223	26,866
Average feed yard capacity	722	1,974	5,426	13,222
Ratio of number fed to average capacity	1:20	1:37	1:52	2:03
Investment in plant and equipment per head fed ($)				
Feed yards	10.15	8.64	8.06	5 64
Grinding and mixing equipment	12.80	8 26	9 50	5.96
Storage and loading equipment	6 29	4.68	3.27	3 67
Feeding equipment	6.19	3 25	2.32	0.94
Other	0 30	0.29	0 25	0.15
Total investment per head fed	35.73	25.12	23.40	16.36
Average daily non-feed cost per head ($)				
Labor (other than office)	0 0445	0 0465	0 0353	0.0395
Depreciation and repair of equipment	0 0150	0 0123	0.0134	0 0097
Taxes (not including taxes on cattle)	0 0086	0 0070	0.0077	0.0056
Interest on investment	0 0172	0 0141	0 0154	0.0112
Fuel and power	0.0073	0 0047	0.0061	0 0052
Veterinary and medicine	0 0038	0 0031	0.0026	0 0027
Death loss	0 0108	0.0090	0 0096	0 0093
Insurance	0 0033	0 0031	0 0033	0 0026
Administration and overhead	0 0097	0.0079	0 0074	0.0084
Gross non-feed costs†	0 1192	0.1077	0.1008	0 0942
Credit for manure	0.0088	0 0088	0 0088	0.0088
Net non-feed cost per head daily	0.1104	0.0989	0 0920	0.0854

* David L. Grove, *Cattle Feeding in California*, 1956.

† Exclusive of marketing costs.

4. Buying of feeds, et cetera, is done in wholesale quantities, often with competitive bids.

5. Buyers for customers' cattle buy many cattle direct from the feed yards, partly because of the large numbers available and sometimes because of the reputation for "killing well" which cattle from a particular yard may have.

It is doubtful if the commercial feed yard will assume as important a role in the traditional cattle feeding areas of the Corn Belt as it has in the West and Southwest. Those feed yards presently found in the Corn Belt are not operating on a custom basis for the most part. Furthermore, they are built around the utilization of some special by-product such as the corn cobs and off-shaped kernels produced by a seed corn producer, or the cannery waste resulting from the processing of sweet corn or peas. Individual cattle feeders are increasing the size of their operations but they are limited in size by the roughage-producing capacity of their farms. Naturally such cattle feeders are just as desirous of reducing their fixed, per head, non-feed costs as are the commercial feed yard operators.

amount of concentrates, depending upon the level of gain desired. The feeding program of those in the latter category is similar in principle to that of the stocker program discussed in Chapter 11, at least in the early stages before the cattle are placed on finishing rations containing a higher level of high-energy concentrates.

Since, as mentioned earlier, most cattle fed in commercial feed yards are fed on a contract or custom basis, it might be of interest to see what the daily per head ration cost was in the California survey already cited. These daily ration costs, summarized in Table 81, must be added to the daily per head non-feed costs to arrive at a minimum daily charge which an operator of a commercial feed yard must charge in order to meet costs when feeds are priced as indicated and when the feed yard is filled to capacity.

Successful commercial feed yards generally have the following characteristics:

1. They are large enough to permit labor specialization; that is, each man does one particular job during an entire day.
2. Precision feed processing and mixing equipment and mechanical feed handling equipment are in use with large numbers on feed, making the use of such equipment economical and possible.
3. Specialists such as veterinarians, nutritionists, and marketing men are employed, with large numbers again making this possible.

Table 81

TYPICAL DRY-LOT AND GREEN FEED RATIONS, WITH COSTS PER STEER FINISHED

Feed	Price per Ton ($)	Dry-lot Ration (120 days) Pounds Fed	Dry-lot Ration (120 days) Total Cost ($)	Green Feed Ration (180 days) Pounds Fed	Green Feed Ration (180 days) Total Cost ($)
Alfalfa hay	27 00	625	8.43	360	4.86
Barley straw	18 00	625	5.63	270	2.43
Barley	45 00	1,155	25.99	540	12.15
Sugar beet pulp	56 00	336	9.41	180	5 04
Cottonseed meal	66 00	291	9.60	180	5.94
Molasses	21 00	372	3.91	360	3.78
Supplement-fortified	120 00	18	1.08	22	1.32
Green feed or silage	9 00	...	...	4,500	20.25
Total feed costs			64.05		55.77
Average feed costs per day			0.53		0.31

Table 82

THE EFFECT OF AGE UPON THE RATE OF GAIN MADE BY FEEDER STEERS WHILE ON FULL FEED*

	Calves		Yearlings		Two-Year-Olds	
	Days Fed	Av. Daily Gain	Days Fed	Av. Daily Gain	Days Fed	Av. Daily Gain
Indiana Bulletin No. 146	270	1.93	180	2.38	180	2.57
Indiana Bulletin No. 146	270	1.82	210	2.06	180	2.65
Indiana Bulletin No. 146	270	1.93	210	2.24	180	2.27
Ohio Bimonthly Bulletins No. 93 and 94	175	2.19	147	2.42	119	2.81
Ohio Bimonthly Bulletins No. 105 and 106	182	2.23	154	2.32	126	2.65
Iowa Bulletin No. 271	240	2.22	180	2.64	120	2.76
Iowa Bulletin No. 271	240	2.32	160	2.47	150	2.48
Average of 7 trials	235	2.09	177	2.36	151	2.60

* All these trials were conducted before the advent of the use of stilbestrol; consequently *the gains are approximately 10 to 20 per cent below presently accepted* standards.

with the result that they gain much more rapidly. Here the daily gains vary directly with the age of the animals, instead of inversely, as shown in Table 82.

Effect of Age upon Economy of Gains. Numerous experiments *point to the fact that young animals require* less feed for each pound increase in body weight than do older cattle. The principal explanation of this is found in the fact that increases in the body weight of young animals are partly due to the growth of muscles, bones, and vital organs, whereas the body increases of older cattle consist largely of deposits of fat. Fat contains much less water and a great deal more energy than an equal weight of any other kind of animal tissue. Hence, more feed is required for its formation. *Other factors contributing* to the more economical gains made by young animals are (1) a slightly larger consumption of feed in proportion to their body weight, and (2) the much greater thoroughness with which young cattle masticate their feed in eating and rumination. As a result of

chapter **13**

THE IMPORTANCE OF AGE AND SEX IN GROWTH AND FINISHING

An increased demand by the consuming public for smaller and lighter cuts of beef has arisen during the past 30 years. Hence there is a tendency for producers to market their cattle at younger ages than was considered advisable or even possible 40 or 50 years ago. Whereas in former times the custom was to market steers at 3 and 4 years of age, yearlings and 2-year-olds now make up the larger percentage of market receipts of slaughter steers. At one time the term "feeder steer" signified to both rancher and cattle feeder a 2½- or 3-year-old animal weighing around 1,000 pounds. At present, both of them insist on qualifying the term and speak of "2-year-old feeders," "yearling feeders," and "feeder calves." Which age of animals to feed is one of the important questions to be decided by every man who plans to feed cattle.

Effect of Age upon Rate of Gain. A discussion of the effect of age upon the daily gains made by cattle must necessarily be treated from two standpoints: (1) its effect upon cattle that have been sufficiently well fed from birth to permit them to grow and fatten at the same time; and (2) its effect upon cattle that are suddenly given a finishing ration after having been fed for some time on a ration that would produce only growth. Inasmuch as cattle make their most rapid growth during the first year and grow more slowly as they approach maturity, it is evident that in cattle fed a full feed from weaning onward the rate of gain varies inversely with age. Young purebred cattle that are being developed for show purposes and are fed liberally from the time they are old enough to eat, gain about 70 per cent as much the second year as they do the first, and 50 per cent as much the third as they do the second.

An entirely different situation exists when thin cattle of different ages are placed in the finishing pen and fed liberally for perhaps the first time in their lives. In this situation the larger capacity of the older steers gives them a decided advantage over the younger cattle,

per cent above that required during the first, in the yearling, 2-year-old, and 3-year-old steers it was 35, 44, and 69 per cent greater, respectively. These figures bear out the fact that calves may be fed profitably over a longer period than older cattle. If necessary they can be held for a considerable length of time, awaiting a favorable market, and all the while they will be making fair gains at not too great a cost. Mature steers, on the other hand, are held at great expense. After being on full feed for 150 or 160 days they gain very slowly, and the additional weight is achieved only by a very wasteful and extravagant use of feed.

The fact that feeding cattle to excessive finish is uneconomical is further demonstrated by the data in Table 86 It will also be noted

Table 85

INFLUENCE OF AGE UPON THE VARIATION IN ECONOMY OF GAINS THROUGHOUT THE FEEDING PERIOD*

Feed per Hundredweight Gain

Period	Three-year-old Steers	Two-year-old Steers	Yearlings	Calves
	lbs.	lbs.	lbs.	lbs.
1st 100 Days				
Corn	586	597	531	431
Alfalfa	363	346	301	221
2nd 100 Days				
Corn	1282	1085	916	623
Alfalfa	320	272	219	148
Total 200 Days				
Corn	835	798	702	520
Alfalfa	350	314	266	186

* Nebraska Bulletin 229.

that, although the total investment in feed required to finish a calf is higher than for the older steers, the cost of gain is less, making it more nearly possible to realize a profit from the feeding margin, as indicated earlier.

Effect of Age upon Length of Feeding Period. Enough has already been said to indicate that young cattle can be fed longer with profit than old cattle. If feeder steers of different ages are started on feed in approximately the same state of flesh or condition.

Table 83

INFLUENCE OF AGE UPON ECONOMY OF GAINS*

Age	30–360 days	360–720 days	720–1080 days	1080–1440 days
Dry Matter per lb. Gain	5.08 lb.	11.26 lb.	17.02 lb.	23.45 lb.

* Missouri Research Bulletin 43.

their relatively large feed consumption, younger cattle use a smaller percentage of the ration to satisfy maintenance requirements than is used for this purpose by older animals, thus making available a greater percentage of the total feed consumed for the production of growth and fat.

Table 83 shows the effect of increasing age upon dry matter requirements per pound of gain by yearly periods. The effect of difference in age of feeder steers at the beginning of the feeding period upon the average feed requirements per 100 pounds gain for the entire feeding period is shown in Table 84.

The cheaper gains made by young cattle than by old become more and more evident as the feeding period progresses. This fact is well illustrated in Table 85, which shows the results obtained at the Nebraska Experiment Station with steers of various ages fed for a period of 200 days. Whereas in calves the total feed required per hundred pounds gain during the last half of the period was only 18

Table 84

EFFECT OF AGE UPON RATE OF GROWTH AND FATTENING
Average Weight of Steers at Chicago Fat Stock Show. 1878–1885*

Class	Number of Cattle Averaged	Average Age in Days	Average Live Weight (Lbs.)	Daily Gain from Birth (Lbs.)	Gain for Last Period: Total (Lbs.)	Gain for Last Period: Daily (Lbs.)
Calves...........	30	297	780	2.63	780	2.63
Yearlings..	152	612	1331	2.18	551	1.76
Two-year-olds......	145	913	1639	1.74	305	.92
Three-year-olds	133	1283	1938	1.51	299	.87

* Average of the 7 trials which appear in Table 82.
† For experiments where corn silage was fed, 15 per cent of the weight of silage was considered its shelled corn equivalent, and 25 per cent its dry roughage equivalent.

total gain necessary to finish decreases slightly with advanced age. In general this gain is approximately as shown in the tabulation.

Age	Total Gain Necessary to Finish
Two-year-olds	300–400 lb.
Yearlings	400–500 lb.
Calves	450–550 lb.

When expressed in terms of the ratio of initial weight as feeders to final weight, however, the differences in total gains are significant. Calves nearly double their weight while in the feed lot; yearlings increase in weight approximately 70 per cent, and 2-year-olds are 30 to 40 per cent heavier at the end of the finishing period than they were at the beginning. Obviously these percentages are greatly affected by the condition of the steers when started on feed.

Effect of Age upon Total Feed Consumed. The age of the cattle has comparatively little effect upon the amount of feed required to attain a given degree of finish, provided all ages are given a full feed of grain and a reasonable amount of high-quality roughages throughout the feeding period. The longer feeding period of the younger animals tends to make up for their smaller daily consumption of feeds, so that by the time they have attained the desired finish they have eaten about as much grain, protein concentrate, hay, and other feeds as older cattle would have eaten in a shorter time. Consequently, the age of the cattle has relatively little effect upon the number of animals that should be purchased to utilize a given amount of feed, if it is assumed, of course, that the feed supply is equally well suited for finishing calves, yearlings, and 2-year-old steers. (See Table 87.)

Table 87

EFFECT OF AGE OF CATTLE UPON THE AMOUNTS OF FEED REQUIRED TO ATTAIN "CHOICE" FINISH*

	Calves		Yearlings		Two-Year-Olds	
Feed	Pounds	Bushels or Tons	Pounds	Bushels or Tons	Pounds	Bushels or Tons
Shelled corn	2,735	48.8	2,696	48.1	2,811	50.2
Protein concentrate	452	0.23	405	0.20	372	0.19
Dry roughage	1,139	0.57	1,183	0.59	1,203	0.60

* Average of the 7 trials which appear in Table 82

Table 86

EFFECT OF LENGTH OF FEEDING PERIOD AND FINISH UPON COST OF GAIN OF CHOICE STEERS FED IN DRY LOT*

Gain	400-lb. Calf	640-lb. Yearling	840-lb. Two-Year-Old
First 100 lb	$ 13 05†	$ 15.75	$ 16.05
Second " "	14.55	18.45	19.65
Third " "	16.35	21.45	25.20
Fourth " "	18 60	26.25	35.10
Fifth " "	23.40	33.60	$24.45 for 50 lb.
Sixth " "	26.10	...	...
Seventh " "	32.85	..	...
Total gain, lb.	700	500	450
Total cost	$144.90	$115 50	$120.45
Av cost per cwt. gain	$ 20 70	$ 23.10	$ 26.77

* Data from U.S.D A. Technical Bulletin No. 900.

† Based on $1.50 per bu corn with other feeds comparably priced.

the time required to finish each age of feeder to the same grade varies inversely with the age of the cattle. When cattle are finished for their grade they should be marketed as soon as possible. To hold them longer requires both feed and labor, for which little is realized, either from increased weight or enhanced killing merit. On the basis of many experiments that have been carried on by different investigators, as well as the experiences of practical feeders, it may be stated that 5 to 6 months of heavy feeding are required for 2-year-old feeder steers to be put in choice to prime condition; 6 to 7 months for yearlings; and 8 to 9 months for calves. It should, of course, be understood that large numbers of cattle are marketed after a relatively short feed before they are really finished. The increasing demand for leanness in beef cuts may make short feeding more practical but it must be recognized that with short-fed cattle, profits must come from favorable price spread. Short-fed cattle do not provide a market for much feed, and a drastic shift to this program by large numbers of feeders would tend to increase the demand for the lower grades of feeders commonly used. Thus feeder cattle costs would be too high to permit the necessary price spreads.

Effect of Age upon Total Gain Required to Finish. There is not a great deal of difference in the increase in weight that must be realized by feeder steers of different ages to attain the same degree of finish. If the cattle are in equal condition when put on feed, the

total gain necessary to finish decreases slightly with advanced age. In general this gain is approximately as shown in the tabulation.

Age	Total Gain Necessary to Finish
Two-year-olds	300–400 lb.
Yearlings	400–500 lb.
Calves	450–550 lb.

When expressed in terms of the ratio of initial weight as feeders to final weight, however, the differences in total gains are significant. Calves nearly double their weight while in the feed lot; yearlings increase in weight approximately 70 per cent, and 2-year-olds are 30 to 40 per cent heavier at the end of the finishing period than they were at the beginning. Obviously these percentages are greatly affected by the condition of the steers when started on feed.

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Dry roughage	1,139	0.57	1,183	0.59	1,203	0.60

* Average of the 7 trials which appear in Table 82

Effect of Age upon Quality of Feeds Used. Although the age of the cattle has little effect upon the amounts of grain, protein concentrate, and good-quality hay required to attain a good or choice finish, it exercises much influence upon the possibility of limiting the grain ration to something less than a full feed and supplying more roughage to take its place. Such a practice may be fairly satisfactory with long yearlings and 2-year-olds but not with calves, which lack the digestive capacity for large amounts of bulky feeds. Two-year-old steers may be fed large amounts of silage or given free access to good-quality hay without depressing their consumption of grain below the amount required to produce a satisfactory finish, whereas such a practice with calves would be almost certain to affect the finish adversely. Calves usually are fed at least 2½ times as much grain as roughage after attaining a full feed. Two-year-olds and yearlings, on the other hand, frequently eat only 1½ to 2 times as much grain, respectively, as the weight of roughage consumed.

This fact is of much importance from a practical standpoint. When it is desired to utilize considerable roughage, such as silage or hay, yearlings or 2-year-old feeders should be purchased rather than calves It is often possible to put a fair "kill" on mature cattle by feeding roughage alone. Calves fed on such a ration are not likely to improve noticeably in condition. The small capacity of their digestive systems would limit their consumption of such feeds to little more than the amounts necessary for maintenance and normal growth

The greatest difficulty experienced in feeding calves is getting them to eat a sufficient amount of feed to enable them to grow and finish at the same time. Older cattle do not have this growth requirement to meet; consequently, a greater percentage of their feed is available for the production of finish or fat. Moreover, calves are much more likely to develop peculiar eating habits than are older cattle. Musty or slightly spoiled feed that would be eaten readily by older cattle is often rejected by calves Likewise, when coarse or stemmy hay is fed to calves, a considerable portion is refused. No attempt should be made to feed calves unless the feeds at hand are of good quality. A somewhat more careful preparation of their ration is advisable in order to render it more palatable and thereby increase its consumption.

It should be realized that calves are "babies" and, hence, have to be better sheltered, more kindly treated, and fed with a little more care than older animals. This care does not mean, however, that they should be "coddled" along or fed highly expensive feeds.

Effect of Age upon the Utilization of Pasture. Because of their limited capacity for feed, yearlings finish less rapidly on pasture than do older cattle. (There are relatively few *calves* available for grazing in the spring, since most of the calves born the previous year are *yearlings* by then.) Fresh grass is a bulky feed with a high moisture content. Therefore yearlings scarcely get more digestible nutrients *from pasture than they need for maximum growth, leaving* little for the improvement of condition. Two-year-old steers, on the other hand, have little additional growth to make Consequently, nearly all the nutrients consumed above maintenance requirements are available for the production of fat. For this reason older cattle are more popular than yearlings in the better grazing areas of the country, where many cattle are sold for slaughter directly off grass without the feeding of any grain. Even when grain is fed on pasture, yearlings finish less satisfactorily than 2-year-olds because they tend *to eat too much of the green pasture forage to enable them to attain* maximum finish. This does not mean that yearlings do not make more gain per acre on pasture than 2-year-olds, but that their gain is in the form of growth rather than fat.

Effect of Age upon Capital Investment. Although feeder calves usually cost from $2 to $4 a hundred more than yearling feeders of the same grade and from $3 to $5 a hundred more than 2-year-olds, they cost much less per head because of their lighter weight. This is a factor of great importance when feeder cattle are high in price. *For example, a 400-pound calf at 25 cents a pound costs $100, whereas* a 650-pound yearling at 22 cents costs $143 and a 900-pound 2-year-old at 20 cents costs $180. Consequently, $9,000 would be required to buy fifty 2-year-old cattle, but only $5,000 would be needed for the same number of calves.

Calves, on the other hand, tie up capital in cattle and feed for a longer period, since they must be fed for a longer time. They also require a slightly higher capital investment in buildings and equipment, because they require somewhat better shelter than do older cattle.

Effect of Age upon the Flexibility of Feeding and Management. Young cattle have a marked advantage over older cattle from the standpoint of their suitability for different methods of feeding and management. Calves may be put on feed immediately or carried on roughage and pasture for 5 to 12 months before being started on a *finishing ration.* Yearlings, too, may be roughed through the winter but are less satisfactory than calves for such a plan of feeding because their gains are relatively slow and expensive Two-year-old steers are usually started on feed soon after their arrival at the farm, since

growth while they are on rations that are not sufficently abundant or nutritious to promote the formation of fat.

Frequently men buy cattle of the age and weight that can most easily be made ready for market by the time they expect the highest prices for finished cattle the following year. Such a course of action is ideal in theory, but often too many cattlemen make the same "guess" as to when the market will be high, with the result that prices at that time are not very satisfactory. As a rule, the better plan is to purchase cattle of the age which is most able to utilize the feeds available and which will be in condition to sell to advantage when the feed supply is gone or when it is necessary to market them to avoid a shortage of labor in the fields.

Importance of Sex in Cattle Feeding. On the basis of sex differences, feeder cattle are classed as either steers, cows, heifers, or bulls. From the standpoint of numbers, steers are of more importance than the other three classes combined and are the only kind of cattle that can be found in fairly large numbers throughout the entire year. Table 88 shows the composition of the annual U. S. cattle slaughter

Table 88

COMPOSITION OF CATTLE SLAUGHTER: ESTIMATED PERCENTAGE FED, AND PERCENTAGE DISTRIBUTION BY CLASS (1945–56)*

Year	Total Slaughter† (1,000 head)	Fed Cattle: Number (1,000 head)	Fed Cattle: Percentage of Total (%)	Percentage by Class‡: Steers (%)	Heifers (%)	Cows (%)	Bulls and Stags (%)
1945	21,694	6,936	32.0	45.8	11.2	39.1	3.9
1946	19,824	5,997	30.3	47.0	11.6	37.8	3.6
1947	22,404	6,341	28.3	44.9	12.6	38.8	3.7
1948	19,177	5,805	30.3	44.3	11.4	40.6	3.7
1949	18,765	7,800	41.6	53.6	11.3	31.6	3.5
1950	18,614	7,411	39.8	53.0	10.6	32.6	3.8
1951	17,084	7,198	42.1	52.0	10.1	33.7	4.2
1952	18,625	8,013	43.0	54.5	10.7	31.1	3.7
1953	24,465	8,648	35.3	53.6	11.6	31.7	3.1
1954	25,889	8,893	34.4	50.3	13.4	33.8	2.5
1955	26,587	10,071	37.9	48.8	14.0	34.9	2.3
1956	27,754	10,642	38.3	51.1	14.1	32.8	2.0

* U.S.D.A. *Livestock and Meat Situation*, 1958.

† *Includes farm slaughter.*

‡ Reported for federally inspected slaughter.

by class or sex condition. It will be seen that steers make up about half of the total, and that less than half of the cattle slaughtered are classed as fed cattle. It can safely be assumed that a considerably larger percentage of the steers are fed before slaughter than is the case with the other classes. The trade in feeder cows and heifers assumes considerable volume only during the fall and early winter months, and feeder bulls have become so scarce that commission men usually ask for at least a week in which to get together a truckload.

Heifers, other than heifer calves, and cows are better suited for a short than a long feed. Older heifers have probably been bred previously to their appearance on the market and are likely to show unmistakable signs of pregnancy if kept longer than 90 to 120 days. Even if evidence of pregnancy is not to be feared, it is seldom a profitable practice to feed cows and heifers for as long as steers of the same condition and quality, since the market does not require that female beef be in such high condition as steer beef. The most attractive heifer carcasses are produced by animals weighing 700 to 900 pounds, showing good condition and finish, but not so fat as to be wasteful. Heifers of this description sometimes sell for nearly the same price as steers, and loads of mixed yearling steers and heifers are often sold with no sorting. Animals in good condition at this weight are about 12 to 15 months old, at which age there is very little likelihood of the females' being pregnant.

Heifer calves finish a little earlier than steer calves. This, together with the fact that heifers need not be so well finished as steers, results in heifers being ready for the market some 6 to 10 weeks before steers, started on feed at the same time. However, with only a single load of calves on feed, a common practice is to send all to market together, even though the heifers may be a little too fat or the steers a little underfinished Usually better prices are received if they are sold separately, when each has attained the finish desired for yearling cattle of that age and sex

The gains made by heifers while on feed are somewhat smaller and more costly than those made by steers, as will be seen in Table 89. This cost is due to the slower rate of growth of heifers. As previously explained, the largest and cheapest gains are secured during that period of life when the rate of growth is most rapid. From this one would expect that, as between two animals, the one having the higher rate of growth would show both more rapid and more economical gains. However, this point is of little practical importance for the reason that steers are usually fed several weeks longer than are heifers Consequently, any advantage they may have over heifers in rate and

Table 89

COMPARATIVE FEEDING QUALITIES OF STEER AND HEIFER CALVES WHEN BOTH ARE FED THE SAME LENGTH OF TIME

	Minnesota Bulletin No. 300		Missouri Bulletin No. 314: Full-fed in dry lot		Missouri Bulletin No. 314: One-half grain ration in winter; full-fed on grass in summer	
	Steer Calves	Heifer Calves	Steer Calves	Heifer Calves	Steer Calves	Heifer Calves
Days fed	217	217	182	182	322	322
Initial weight, lb.	451	449	359	358	358	354
Av. daily gain	*2.35*	*2.27*	*2.16*	*1.94*	*1.84*	*1.64*
Av. daily ration.						
Shelled corn	12.1	12.1	8 0	8 0	8.3	8 0
Prot. conc.	2.0	2.0	1.1	1.1	1.2	1.1
Alfalfa hay	1 6	2.1	3.2	3.2	1 8	1.9
Corn silage	7.6	8.9	8.7	8.9	5 5 (pasture)	5 5 (pasture)
Feed per cwt. gain:						
Shelled corn	517	535	369	410	452	483
Prot. conc.	85	88	53	58	65	69
Alfalfa hay	69	93	115	162	97	118
Corn silage	322	391	400	450	297	336
Cost of cattle per cwt.	$8 00	$8 00	$10 40	$ 9.05	$10 40	$9 05
Selling price per cwt.	10 00	9 60	10 60	10 50	14.45	12 60
Return above cost of *feed (ex. pork)*	*9 43*	*2.60*	*8.30*	*8 16*	*38.43*	*21.14*
Dressing percentage	..	..	57.3	59 1	59 5	60 3

economy of gains at the time the heifers are marketed is likely to *disappear during the remaining weeks they are continued on feed* when their gains are both slow and expensive relative to those made earlier. Indeed it frequently happens that heifers make larger average daily gains and also cheaper gains during a period of 5 or 6 months than do steers during a feeding period which is 2 or 3 months longer (see Illinois Experiment, Table 90).

A factor of much greater importance than the relative rate and economy of the gains made by steers and heifers is their relative selling price when marketed. The marked preference of the butcher and consumer for steer beef is probably founded largely on the fact that in the early days of the beef industry most heifers were retained for breeding purposes, and the only "she" stock marketed were old cows. Later, the heifers not needed for the breeding herd were allowed to remain on the farms and ranches until they were 2 years

Table 90

Comparative Feeding Qualities of Steers and Heifers When Each Is Marketed When the Finish Required for the Respective Sex Is Attained*

	Iowa Exp. Station (av. of 3 tests)		Ill. Exp. Station	
	Steer Calves	Heifer Calves	Steer Calves	Heifer Calves
Number of days fed	240	170	200	140
Av. initial weight, lb.	415	406	379	379
Av. daily gain	2.18	2.18	2.35	2.56
Av. daily ration:				
Shelled corn	10.7	9.1	10.1	9.3
Protein concentrate	1.5	1.5	1.5	1.4
Alfalfa hay	4.9	5.4	2.0	2.0
Corn silage	...	...	8.1	8.2
Feed per cwt. gain:				
Shelled corn	492	433	428	363
Protein concentrate	65	65	63	54
Alfalfa hay	226	247	85	78
Corn silage	...	...	343	319
Cost per cwt. in lots	$6.93†	$6.13†	$ 9.90	$ 9.28
Selling price at Chicago	7.95†	6.40†	12.85‡	10.75
Date marketed	July 18	May 6	July 13	May 14
Return above feed cost per head (ex. hogs)	$11.70†	$0.78†	$23.98	$10.94

* Mimeographed Reports of Calf-feeding Experiments.

† Average of last 2 years; first year discarded because of abnormal market conditions.

‡ The estimated value of the steers was $10.65 per cwt. at the time the heifers were sold. The market advanced approximately $1 after this date; the additional $1.20 indicates enhanced killing merit acquired during the last 60 days of feeding.

old, since the marketing of younger cattle was then very uncommon. The heifers usually were pregnant and were not satisfactory for further feeding; hence, they were sold to the packer for slaughter despite their thin condition. The carcasses of these heifers, as well as those of the old cows, were purchased by butchers whose customers could buy only cheap beef. Thus it has come about that the sex of the carcass is regarded as an index of its quality, and hotels, clubs, and the best butcher shops seldom buy heifer carcasses no matter how good or how cheap they may be. Consequently the price of these carcasses cannot rise above the relatively low ceiling at which the great majority sell readily to the consumers who buy their meat on the basis of price per

pound instead of quality. This price is reflected to the live cattle, with the result that heifers usually sell from $2 to $4 a hundred below the price paid for steers of similar quality and finish. Feeders, realizing that the market pays little premium for the finish required to make a heifer grade prime, usually market heifers as soon as they grade high good or a little better. As a result the average price of grain-fed heifers is frequently $3 to $5 a hundred below the average price of grain-fed steers.

Mention has been made of the fact that heifers acquire a satisfactory market finish more quickly than do steers. This point favors their purchase when a short feeding period is desired to permit selling the cattle before a seasonal decline in prices is expected to occur, but is a disadvantage if they reach a satisfactory market finish at a time of year when prices of finished cattle are relatively low. For example, heifer calves that are full fed during the winter are usually ready for market in May and June, when steers of the better grades command

Table 91

Comparison of Steers and Heifers for Utilizing Large Amounts of Roughage and Pasture, After Which They are Given a Short Feed of Grain in Dry Lot*

	Steers (Dec. 14, 1948–Jan. 6, 1950)	Percentage of Total	Heifers (Dec. 14, 1948–Dec. 9, 1949)	Percentage of Total
Average initial weight, pounds	544		475	
Average winter gain (Silage, hay, protein concentrate)	174	28	153	30 7
Cost of winter gain per cwt.	$15 78		$16 46	
Average summer gain, pounds (*Grass-legume pasture*)	*215*	*34 6*	*199*	*39 9*
Cost of pasture gain per cwt.	$ 5 30		$ 5 73	
Average fall gain, pounds (Fed in dry lot)	232	37.4	147	29 4
Cost of dry lot gain per cwt.	$21 37		$20 32	
Average total gain, pounds	621	100	499	100
Cost of total gain per cwt.	$14 26		$13 12	
Cost price per cwt.	$28 65		$26 25	
Date sold†	Jan 6		Dec 9	
Selling price per cwt.	$27 00		$22 75	
Dressing percentage	58 8		56 9	

* Missouri, Livestock Day Progress Report 10, April, 1950.
† Both lots sold when it was believed they would grade "good" as slaughter cattle.

relatively low prices, whereas steers of the same age and condition that were started on feed at the same time ordinarily are fed until August or September, when prices are usually much higher.

Steers usually are preferred to heifers for roughing through the winter and grazing on pasture the following summer because they grow more and therefore make larger gains on non-fattening feeds. Moreover, yearling heifers, after a summer on pasture and a short period of grain feeding in the dry lot command lower prices than steers because of the competition they encounter from the larger number of grass-fat heifers that are marketed in the fall. (See Table 91.) Short-fed steers do not experience serious competition from grass-fed steers, since most of the grass-fed steers are sold for further feeding rather than for immediate slaughter.

Effect of Pregnancy. Producers often criticize the allegedly unjust discrimination against finished heifers. The packers reply by pointing to their inability to sell heifer carcasses to the select trade and by calling attention to the fact that a majority of the heifers are pregnant when purchased and therefore yield a relatively low percentage of dressed beef. Pregnancy, they say, is so common in female cattle that the buyer is forced to protect himself by buying all females on a pregnancy basis. Thus producers have no scruples against breeding their heifers soon after starting them on feed, particularly since many feeders believe that pregnancy favors more rapid and more economical gains, both by lessening feedlot disturbances caused by heifers which are in heat, and by hastening the attainment of a satisfactory market finish by increasing their tendency to fatten.

It has long been recognized that pregnancy has an important effect upon the feeding and killing qualities of cattle. However, the precise nature and extent of this effect has been a matter of considerable

Table 92

EFFECT OF PREGNANCY UPON THE DEVELOPMENT OF YEARLING HEIFERS*

Average difference noted between 5 pairs of bred and open heifers during the first 150 days of gestation

1. Increase in ht. at withers	−0.80 cm	7. Wt. of green hide	− 9.6 lb.
2. " " circ. of paunch	+2.50 "	8. Wt. of uterus	+28.6 "
3. " " width of loin	−1.55 "	9. Score of dressed carcass	+ 2.75
4. " " length of body	−2.50 "	10. Wt. of carcass lean	−12.4 lb.
5. Gain in weight	+4.0 lb.	11. " " " fat	+27.7 "
6. Dressing percentage	−0.17%	12. " " " bone	− 5.3 "

* Illinois Experiment Station, Unpublished Data

disagreement. Some feeders have advanced the theory that the embryo imposes a tax upon the young mother and thereby interferes with her growth and development. Others have regarded the relationship between mother and fetus as symbiotic, whereby the well-being of the mother is enhanced by the presence of the young *in utero.* Results of experiments carried on at the Illinois station are summarized in Table 92. Indications are that both these theories are in some respects true. Following is a summary of the results of a paired comparison of open and bred yearling heifers fed equal quantities of feed for approximately 5 months. Each pair was slaughtered on the 150th day of the gestation period of the pregnant heifer.

1. *Activity.* Bred heifers were less active than open heifers. They spent more time lying down and were more gentle and more easily handled.

2. *Appetite.* Although both bred and open heifers were fed at the same level of intake, the bred animals showed a desire for more feed than the open heifers could be made to consume.

3. *Growth.* Pregnancy exercised a noticeable inhibitory effect upon growth. This effect was apparent in the decreased development of the rear quarters and in the smaller size of the bones and internal organs.

4. *Rate of Gain.* Pregnancy had no appreciable effect upon skeletal growth, nor did it affect the rate of gain in weight during the first 5 months of gestation.

5. *Apparent Slaughter Merit.* Pregnancy had an unfavorable effect upon the apparent slaughter merit of the heifers, as was indicated by consistently lower scores assigned to the bred heifers at the end of 150 days of gestation. These heifers were criticized severely on "straightness of lines" and "smoothness of finish."

6. *Dressing Percentage.* The dressing percentage of the bred and open heifers was almost the same when calculated on their weights after an overnight fast. Apparently the lighter hides, heads, shanks, stomachs, and other items of offal overcame a large part of the handicap imposed by the pregnant uterus, which averaged about 30 pounds at the time of slaughter.

7. *Appearance of the Carcass.* Pregnancy had a markedly favorable effect upon the appearance of the dressed carcass. The carcasses of the pregnant heifers were noticeably better finished but not to the extent that they were criticized for being "wasty."

8. *Weight of Wholesale Cuts.* No effect of pregnancy upon the relative weight of the wholesale cuts was observed except in the flank,

loin end, and round, all of which were significantly lighter in the bred than in the open heifers.

9. *Physical Composition of the Carcass.* The carcasses of the bred heifers contained approximately 5 per cent more fat but 3.5 per cent less lean and 1.5 per cent less bone than the carcasses of the open heifers.

10. *Color and Firmness of Fat.* Pregnancy had no significant effect on the color of either the fat or lean meat. However, the back fat of the bred heifers was slightly softer than that of their open mates.

The findings of this experiment apparently justify the breeding of full-fed yearling heifers 3 or 4 months before they are to be marketed. They also render untenable the claim of market buyers that finished yearling heifers, like cows, must be bought at a considerably lower price because of the probable losses due to pregnancy. However, as long as market buyers have this opinion, producers will do well to recognize it and market their heifers open or at least no later than the fourth month of gestation, since pregnancy is clearly apparent by the end of the fifth month.

An injectible form of diethylstilbestrol, marketed under the trade name of "Repositol," is now being used by veterinarians, with approximately 70 per cent effectiveness, in aborting pregnant heifers at about the fourth or fifth month of pregnancy. There are some temporary physiological side effects, such as uterine prolapse in the extreme cases, but in general the practice is successful and feedlot performance continues to be normal.

Spayed vs. Open Heifers. One of the principal objections to feeding heifers is the disturbance caused by their coming in heat. When a carload or more of heifers are fed together, hardly a day passes without one or more animals being thus affected, so that the herd is frequently in a state of excitement and unrest. Obviously such conditions are not conducive to rapid and economical gains.

In order to avoid the disturbances caused by in-heat heifers, producers sometimes resort to spaying. More heifers are not spayed because of the extra cost of such feeder heifers and the failure of the market to pay sufficient premiums for such heifers to cover the extra cost. The principal advantages claimed for spaying are a more tranquil disposition in the animals during the feeding period and a somewhat higher price for them when they are marketed. However, spayed heifers seldom have made as large or as economical gains or have attained as high a finish as open heifers in feeding experiments in which they have been compared. Apparently the removal of the

Table 93

COMPARATIVE FEEDING QUALITIES OF STEERS, SPAYED HEIFERS, AND OPEN HEIFERS*

Average of Two Tests 1924-26	Yearlings			Calves		
	Steers	Spayed Heifers	Open Heifers	Steers	Spayed Heifers	Open Heifers
Av. initial weight, lbs....	635	589	570	382	386	390
Av. daily gain..........	2.10	1.89	2.15	2.07	1.66	1.92
Feed per lb. gain:						
Shelled corn.........	702	723	665	502	619	544
Alfalfa hay..........	340	380	340	287	355	310
Initial value per cwt.....	$7.90	$6.40	$6.15	$7.60	$5 50	$6.25
Final value per cwt......	9.65	8.65	8 75	9 40	9 40	9.25
Dressing percentage.....	60.17	59.78	60.67	57.25	59 03	60.72

* Nebraska Bulletin 252.

ovaries retards the growth and development of young heifers in much the same way that castration retards the growth and development of male calves. Spaying by simply severing the oviduct insures that pregnancy does not occur but produces no benefits otherwise.

Since spayed heifers gain less rapidly than open heifers, spaying cannot be recommended on the ground that it lessens activity in the feed lot and thus results in faster gains. As a matter of fact, disturbances caused by in-heat heifers usually are most noticeable during the first few weeks of the feeding period and tend to become less and less frequent as the heifers approach market finish. Consequently, any advantage possessed by spayed heifers must lie in the certainty that they are not pregnant and therefore may be purchased for a long feeding period without danger of their being far advanced in gestation by the time they are ready for market.

Feeding Cows. Large numbers of cows are marketed each fall by farmers and ranchers. Many of these cows have been suckling calves all summer and are very thin; consequently, they frequently are considered satisfactory for feeding, particularly if they can be bought for only about half the cost per pound of choice feeder calves and yearlings.

Although feeder cows often appear to be worth the money when they are bought in the fall, they frequently prove to be a rather sorry bargain by the time they are marketed. Many misfortunes may occur

when they are sold. Men who buy cows to feed frequently change their plans upon discovering that most of the cows appear to be pregnant, and they decide to keep them until fall and fatten them after the calves are weaned. Then, however, the grain already fed yields little return, since the flesh put on during the winter is lost to a large extent during the suckling period. Seldom do all the cows kept prove to be in calf. These barren cows may be sold directly *off pasture the following fall, but if sold at this time of year they may* not bring much more per pound than they cost a year earlier.

Cows fed during a period of rising prices frequently return very satisfactory profits and yield a high return on the amount of money invested. Also, the return realized per bushel of corn fed may be very high for the reason that cows usually are fed a limited grain ration or a full feed for only a short time.

chapter 14 THE IMPORTANCE OF GRADE IN FEEDER CATTLE

Which age and sex of cattle to buy are only two of the many *questions that confront the man needing feeder cattle.* In addition, he must decide between animals of one breed and those of another; and between top-quality feeder steers, which cost perhaps 30 cents per pound, and nondescript, trashy cattle, which can be purchased at almost half this figure. At most seasons of the year feeder cattle of all kinds are available in fairly large numbers at any of the larger markets. Naturally certain markets have a reputation for affording unusually good selections of cattle of a certain breed or grade. Kansas City and Denver, for example, are recognized as probably the best markets at which to buy high-grade Hereford calves; Omaha, as a good place to buy, in late summer or early fall, heavy, grass steers suitable for a short feed; East St. Louis and St. Paul, as places where lower-grade feeders are found in large numbers. If a large number of cattle of a given kind are to be bought it is usually best to go to that market at which the supply is likely to be the largest. However, if only a carload or two is wanted, the market nearest at hand is usually able to furnish them at the lowest cost, freight and other expenses considered.

Kind of Cattle to Buy. No hard and fast rule can be laid down as to what kind of cattle is best to feed. Many factors must be taken into account in deciding this question. Without doubt, the strength of the demand, in relation to the supply, both for the feeder animals and for the finished beeves is likely to be the chief factor in determining the profit made from the feeding operation. Low-grade cattle may prove just as profitable, or more profitable, as choice or fancy feeders if they are purchased at a time when the supply of such *animals is greater than the demand, and sold when the supply* of cheap beef is relatively small. On the other hand, it frequently happens that the supply of prime, well-finished steers is so small that they enjoy a market all their own. Under such conditions the profit

made on such cattle is relatively large, even though the price paid for them as feeders seemed at the time unreasonably high compared with quotations for plainer cattle.

The conditions under which the cattle are to be fed and the way they are to be handled should receive first consideration in deciding on the kind of cattle to buy. For a long feed in which a liberal allowance of grain is furnished, *only the better grades of feeders should be purchased.* Medium or common feeders, on the other hand, can never be made into "market toppers," no matter how long they are fed nor how excellent the ration. To feed such cattle large quantities of expensive feed is likely to prove a wanton waste of money. As a rule they should be fed for a comparatively short time and the cost of the ration should be held at a low figure by the use of considerable roughage.

Kind of Cattle Being Fed. As mentioned in Chapter 11, grade in a stocker or feeder steer is determined by his predicted potentiality as a slaughter animal. Feeding finishing rations for a period of time longer than that usually required to finish a feeder to its corresponding slaughter grade sometimes upgrades an animal, but this is not usually a recommended practice, because only a few animals out of a drove will make it. If one assumes that most animals were graded properly as feeders and fed according to their expected outcome, then data such as those in Table 95 can be used to estimate the percentages of the various grades of feeder cattle fed.

Market Classes and Grades of Slaughter Cattle. Official United States Department of Agriculture standards have been estab-

Table 95

PERCENTAGE COMPOSITION OF THE BEEF SUPPLY BY GRADE*
(1947–1956)

Percentage of Total Beef by Grade

Year	Prime (%)	Choice (%)	Good (%)	*Commercial* and Standard (%)	Utility (%)	*Canner* and Cutter (%)
1947	4.3†	26.7	19.8	18 0	16.6	14 6
1952	*6 0*	*36.2*	*18.7*	*14.0*	*12.7*	*12.4*
1956	4 2	32.8	21.1	15.9	12.9	13.1

* U.S.D.A., *Livestock and Meat Situation,* March, 1958.

† Based on percentage of total weight of beef supply rather than on number of head slaughtered

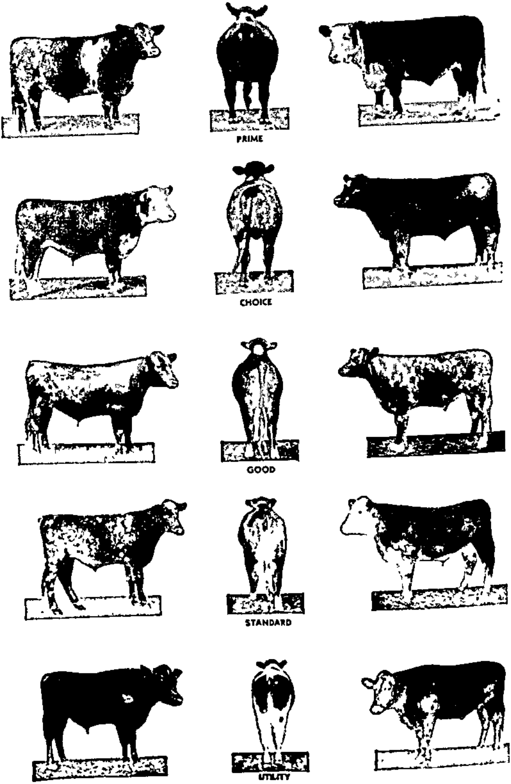

FIG. 65. Steers which illustrate the U.S.D.A. grades of slaughter steers. It is important to be able to judge when a steer is finished for his grade since economy of gain and length of feeding period are so closely related. (U.S.D.A.)

lished for slaughter cattle and beef carcasses just as for stockers and feeders. The slaughter grades or, as sometimes called, "on foot" or "live" grades are based on the predicted carcass grade of an animal after slaughter. Color of fat and lean, interspersion of fat and lean (marbling), and age as determined by bone condition are factors of importance in determining carcass grade which cannot be accurately assessed by examination of the live animal. For this reason slaughter and carcass grades do not always correspond, but experienced buyers do not often miss their evaluations to any great degree.

Figure 65 shows rear and side views of the more common grades of slaughter steers. Slaughter heifers would be expected to have corresponding conformation and degree of finish. Table 96 lists the various grades of slaughter cattle.

Government grading of beef carcasses is done at the request of the packer and thus is a voluntary program. Most government agencies such as the Army and Navy, and many chain stores, as well as restaurants, railroads, and hotels, buy their beef on the basis of government grades. Government graded beef can be identified by the purple shield, bearing the letters "USDA" and the name of the grade, stamped on nearly all retail cuts. Almost all major packers have their own system of labeling the respective grades of beef as well.

The specific grade assigned to a slaughter animal by a grader is determined by its relative excellence with respect to conformation, finish, quality, and maturity or age. Conformation is related to cut-out value or the proportion of higher-priced cuts in relation to the whole. Finish refers to the degree of fatness as well as the quality and distribution of the fat. The latter factor is believed to be associated with palatability, tenderness, and quality of the individual cuts of meat. Quality refers to the over-all symmetry and smoothness of the

Table 96

MARKET CLASSES AND GRADES OF SLAUGHTER CATTLE*

Market Class	Market Grade
Steers	Prime, Choice, Good, Standard, Commercial, Utility, Cutter
Heifers	Prime, Choice, Good, Standard, Commercial, Utility, Cutter, Canner
Cows	Choice, Good, Standard, Commercial, Utility, Cutter, Canner
Bulls	Choice, Good, Commercial, Utility, Cutter, Canner
Stags	Choice, Good, Commercial, Utility, Cutter, Canner
Calves	Prime, Choice, Good, Commercial, Utility, Cull

* Based on U.S.D.A., *Livestock and Meat Situation*, July, 1955

FIG. 66. Fancy feeders are required to make prime slaughter beasts such as these Angus-Shorthorn crossbreds. A small percentage of choice feeders can be made prime if fed long enough, but costly gains usually more than offset higher selling price in this situation. (Corn Belt Farm Dailies.)

animal as well as the refinement of head, hide, and bone. The degree of maturity in the live animal is appraised on the basis of the physical characteristics associated with age. In the carcass, color and hardness of bone are the principal indicators of age. Youthfulness and finish are both believed to be associated with palatability. Preliminary research data indicate that tenderness and palatability are heritable It is conceivable that, in the future, selection for these traits may result in cuts which are tender and palatable without the necessity of feeding to the degree of finish found in high-choice or prime cattle.

Importance of Type. Cattle feeders differ in their opinions as to which type of steer is most profitable to feed. Some prefer small, compact, low-set animals, believing that they finish more readily, have a higher dressing percentage, and produce more shapely carcasses than the conventional type of steer. Others favor large, growthy cattle with plenty of bone and substance, believing that such animals make faster and cheaper gains and return more dollars per head because of their greater weight. Numerous tests have been

made to obtain information on these points, but few of them have disclosed significant differences between the two types. Although the large-type steers usually have gained at a somewhat faster rate, seldom has there been a significant difference in feed conversion, as seen in Table 97.

Although the small and large types of cattle have not, as a rule, shown marked differences when both were full fed for the same length of time, it is possible that one type may be better suited than the other for a deferred system of feeding in which young animals are carried on roughage and pasture for 6 months to a year before they are given a finishing ration. Such an experiment has been carried out at the Kansas, Ohio, and Oklahoma Experiment Stations under the auspices of the American Hereford Association. For this method of feeding the medium type was slightly more profitable than either the

Table 97

EFFECT OF TYPE OF FEEDER STEERS UPON THE RATE AND ECONOMY OF GAIN AND UPON THE CARCASS MERIT

	Calves Average of 3 Trials[a]		Yearlings Average of 9 Trials[b]		
	Small Type	Conventional Type	Compact Type	Medium Type	Rangy Type
Average initial weight, pounds...	338	412	722	752	785
Average total gain	351	438	350	360	373
Average daily gain	1 79	2 14	2 08	2 14	2 22
Percentage gain (gain ÷ initial weight)	104	106	48 5	47.9	47.5
Total feed consumed daily, pounds	12 5	15.1	....	....	....
Total feed consumed daily per 100 lb. av. live weight	2 43	2.42	....	....	....
Total feed consumed per hundredweight gain	702	707	....	....	....
Dig. nutrients per hundredweight gain	476	479	....	....	....
Feeder grade[c]	5.1	4 4	.		.
Fat steer grade[c]	4 4	4 3	5.3	5 5	5 6
Carcass grade[c]	4 5	4 4	5 1	5 1	5 1
Dressing percentage	57.7	58 9	57 4	57 7	58 4

[a] Colorado Agricultural Experiment Station, Mimeograph Report, November, 1950.
[b] *New Mexico Agricultural Experiment Station, Journal of Animal Science, Vol. 5, No. 4, 1946.*
[c] Grading systems. (1) Colorado 6 = fancy or prime, 5 = choice, 4 = good.
(2) New Mexico: 4 = choice, 5 = low choice, 6 = high good.

small or large type, if all calves were purchased at the same price per pound. If, however, they had been bought at the same price per head, the large and medium types would have returned the same profit, since the market value per head less the feed cost would have been nearly the same. (See Table 98.)

Importance of Beef Type. It is generally conceded that cattle of pronounced beef type are more satisfactory to feed than cattle of dairy type. The belief is also common that the greater width and more compact form of the beef steer are conducive to more rapid and more economical gains than can be obtained from a dairy steer fed under similar conditions. Feeding trials do not bear out these contentions. Instead, they show comparatively little difference between the rate and cost of gains made by animals of these two types. Feeding experiments do emphasize, however, the advantages possessed by the steer of beef type in regard to the nature of gains, the quality of flesh, distribution of fat, and dressing percentage. As a result of these advantages, the selling price per pound of the beef-bred animal is very much higher than that of the dairy-bred animal.

Table 98

RELATIVE VALUE OF SMALL-, MEDIUM-, AND LARGE-SIZE HEREFORD CALVES FOR A DEFERRED SYSTEM OF FEEDING*

	Small	Medium	Large
Average initial weight, pounds	401	419	442
Wintering period 150 days			
Average gain	169	172	197
Summer grazing period 98 days			
Average gain	108	115	114
Late summer full-feeding period 101 days			
Average gain	228	233	231
Total gain 349 days	505	520	542
Final weight	906	939	984
Feed cost per head			
Winter period	$28 54	$28.40	$29.51
Summer grazing period	$11 00	$11 00	$11.00
Full-fed period	$47 20	$48 02	$49 43
Total feed cost per head	$86 74	$87.42	$89.94
Feed cost per cwt. gain	$17 18	$16.81	$16.59
Selling price per cwt.	$25 53	$25.78	$24 87
Dressing percentage	57 8	58.1	57.7
Average carcass grade	Low choice[a]	High good[a]	High good[a]

* *The American Hereford Journal*, March 15, 1951.

[a] New grading standards

Table 99

COMPARATIVE FEEDING QUALITIES OF BEEF AND DAIRY STEERS*
(Weighted average of 3 trials)

Average Time Fed — 217 Days	Beef-Type Angus	Cross-Bred Angus-Holstein	Dairy-Type Holstein
Initial weight	475 lbs.	535 lbs.	405 lbs.
Final weight	950	980	915
Average daily gain	2.19	2.05	2.37
Average daily ration:			
Shelled corn and oats	10.4	10.7	10.5
Nit. concentrate	1.7	1.7	1.6
Corn silage	11.8	11.9	11.2
Alfalfa hay	2.9	3.0	2.9
Feed cost per cwt. gain	$12.20	$13.25	$11.15
Initial value per cwt.	10.40	10.00	7.40
Final value per cwt.	13.00	12.15	10.10
Return per head over feed cost	15.75	6.30	5.55
Dressing percentage	61.1	61.7	58.4
Grade of carcasses			
(Total of 3 trials)	8 prime 12 choice 4 good	12 choice 8 good 2 medium	1 good 22 medium 1 fair
Color of Carcass Fat	White	White	*Bluish White*

* Wisconsin Mimeographed Report, 1929.

During three consecutive years the Wisconsin station carried on the feeding experiments summarized in Table 99 involving the feeding of Angus, Holstein, and cross-bred Angus-Holstein calves of approximately the same age. Although some differences were found in the rate and economy of gains made by the various lots, more important differences were noted in the killing qualities of the cattle and in the grade of the beef produced. Whereas the carcasses of the Angus steers were "uniformly blocky, thick, with short shanks, smooth thick and well covered throughout with a relatively small amount of kidney fat," the carcasses of the Holstein steers were "angular and long, loin weak, forequarters heavy and shanks long, lacking uniform thickness, thin exterior covering, kidney fat heavy in proportion to exterior fat." As was to be expected, the carcasses of the cross-bred

steers "closely resembled those of the Angus in shape with a tendency toward heavier forequarters and longer shanks. In finish and covering they were not as smooth with a tendency toward heavier kidney fat." However, the carcasses of these Angus-Holstein steers were rated relatively high by expert meat judges, and it would seem that this kind of crossbreeding might well be considered by dairymen during periods of unsatisfactory milk prices or while switching from dairying to the fat-calf program.

Although the Wisconsin experiments are valuable to the farmer who raises his own feeders and who can raise either beef or dairy calves in the same way if he chooses, they are of little practical value to the cattle feeder who is contemplating the purchase of feeder cattle on the open market, in which case the previous management of the cattle is largely an unknown quantity. Under such circumstances dairy steers are almost always older and noticeably thinner than beef steers of the same weight. Because of these facts they may make larger gains, particularly during a short feeding period. Their low condition may also make for cheaper gains than those made by steers of beef breeding which are in much better flesh. Table 100 illustrates what is likely

FIG. 67. Western raised and Corn Belt fed prime steers such as these provide a market for at least 75 bushels of corn per head. Grain deficit areas, with relatively more roughage to market, are associated with cow herds or short-fed cattle. (American Shorthorn Association.)

Table 100

*Feeding Dairy and Beef Steers**

(154 days — 6 steers per lot)

	Dairy Steers Holstein	Beef Steers Aberdeen-Angus
Average Age	11.5 mos.	10.5 mos.
Condition at Start of Trial	Thin	Fair market *condition*
Initial Weight	626 lbs.	632 lbs.
Daily Gains	2.57	2.21
Daily Ration		
Concentrates	16.50	14.80
Dry Roughage	6.60	3.80
Feed per Pound Gain		
Concentrates	6.42	6.70
Dry Roughage	2.57	1.72
Initial Value per cwt.	$4.25	$7.00
Selling Price in Pittsburg	*$8.50*	*$9.75*
Shrinkage during Shipment	4%	5.8%
Dressing Percentage (Cold)	56.90%	60.72%

* Ohio Monthly Bulletin, Nov.-Dec., 1922.

to happen under such conditions. The trial is in reality a comparison of thin dairy steers with beef steers "already in fair market condition." With this advantage the dairy steers would be expected to excel the beef steers in rate and economy of gain.

It has already been stated that the best kind of cattle to buy depends upon the nature of the feed and pasture supply, the conditions under which the cattle are to be fed and handled, and the relative market price of the different grades. No hard and fast rule can be laid down for feeders to follow year after year in the purchase of their cattle. The majority of feeders should and do follow the conservative plan of handling cattle of average quality as represented by the good and choice grades, leaving to the more experienced and venturesome men the fancy and common grades. However, this statement does not apply to steer calves, the lower grades of which, if full fed until they are sufficiently well-finished for their grade, are ready for market in the late spring or early summer when their selling price may be $3 to $5 a hundred lower than that of choice yearlings fed to their respective grade and marketed in late summer or early fall. Consequently, the

purchase of feeder calves falling below the good grade should be avoided unless they can be purchased at an unusually low price. It should also be realized that losses from death are much larger with low-grade calves than with low-grade animals of greater maturity.

The comparative advantages of the different grades of yearling and 2-year-old steers are well set forth in Illinois Bulletin 90. Extracts of the summary are quoted below:

1. A feed supply higher in roughage than concentrate, and a shorter feeding period tend to favor the feeding of the lower grades.

2. Well-bred steers possess greater capacity for consuming large quantities of feed than do steers of a more common grade, especially in the later weeks of feeding.

3 The greater the cost of feed used, the greater the advantage in favor of the better grades.

4. As a rule, the better the quality and condition, the younger the cattle.

5 Opportunities for larger profits, and losses as well, lie with the better grades of feeders.

6 The grade of cattle on which the finishing will return the greatest profit will depend upon the following considerations:

a. The relative cost of the various grades per hundredweight.

b. The cost of feed.

c. The method of feeding and time of marketing.

d. The range in prices between the different grades of fat steers at the time the cattle are sold.

7 The better the grade of cattle, the higher the percentage of dressed beef.

8 Low-grade cattle carry larger percentages of internal fat than do the better-bred ones, and there appears to be a more abundant and more evenly distributed layer of surface fat on the better-bred steers.

Data gathered in De Kalb County, Illinois, by the United States Department of Agriculture and the University of Illinois throw further light upon the feeding qualities of plain and well-bred cattle. These figures are the result of records kept on the feeding operations of some 40 practical cattle feeders, who handled their cattle according to their usual methods of management. It will be observed that the good steers were on feed a full month longer than those grading common but that, notwithstanding this fact, the gains of the good steers were both larger and cheaper for the entire time they were fed. These results tend to refute the claim sometimes made that the gains made

Table 101

COMPARISON OF GOOD AND COMMON STEERS UNDER ACTUAL FARM CONDITIONS*

	Good Steers	Common Steers
Number of Droves	15	26
Number of Cattle	703	1785
Number of Days on the Farm	174	143
Purchase Weights	888 lbs.	824 lbs.
Sales Weights	1186	1013
Gain in Weight	298	189
Average Daily Gain	1.71	1.32
Feed per cwt. Gain		
Grain and other Concentrates	695	724
Silage	1261	1871
Dry Roughage	327	467
Pasture Days	9	8
Purchase Price per cwt	$7.00	$5.13
Sale Price per cwt. (at farm)	9.07	7.16
Necessary Margin to Break Even	1.52	1.99

* U.S.D.A. Mimeographed Leaflet, "Two Steers on the Same Trail."

by common steers during a short "warming up" feed are as large and as economical as those made by better animals over a longer period. (See Table 101.)

Effect of Grade upon the Time and Feed Required to Attain a Given Finish. The results of an extensive experiment conducted at the Illinois station with the more common classes and grades of feeder cattle are summarized in Table 102. The plan followed was to feed similar rations to three lots of a certain class and grade of feeder, with the first lot being slaughtered when it was felt that the cattle would yield carcasses grading one grade below the feeder grade, the second when it reached the slaughter grade corresponding to the feeder grade, and the third when it reached the slaughter grade above the feeder grade. It will be seen that a poorer job of estimating the carcass grade was done in the heifer lots than in the steer lots.

Importance of Skill in the Selection of Feeder Cattle. The ability to estimate quickly the relative merits of different droves of feeder cattle and the skill in selecting thrifty, healthy animals that will make rapid and economical gains can be acquired only by experience and practice. Such ability pays off in dollars and cents, however, as may be seen from the Kansas experiments reported in

Table 102

TIME AND FEED REQUIRED TO FINISH BEEF CATTLE TO VARIOUS SLAUGHTER GRADES*

Av. Initial Wt. (lb.)	Av. Days Fed	Days± from Middle Grade	Av. Final Wt. (lb.)	Av. Total Gain (lb.)	Av. Daily Gain (lb.)	Total Corn Fed (bu.)	Corn per Cwt. Gain (lb.)	Cost per Cwt. Gain† ($)	Av. Carcass Grade
				Choice Steer Calves					
	145	−90	771	291	2.01	24.4	405	17.37	Good
480	235	0	938	458	1.95	42.8	476	19.29	Choice
	358	+123	1,163	683	1.91	67.4	553	21.48	Prime
				Choice Heifer Calves					
	154	−83	714	284	1.84	23.6	398	17.22	Good
430	237	0	871	441	1.86	41.8	484	19.54	Good
	268	+31	932	502	1.89	49.2	507	20.14	Choice
				Medium Yearling Steers					
	69	−52	934	154	2.23	11.0	400	22.28	Comm.
780	121	0	1,073	293	2.43	23.2	444	22.26	Good
	164	+43	1,153	373	2.48	34.2	514	24.82	Choice
				Good Yearling Steers					
	95	−52	891	231	2.43	20.3	377	17.65	Comm.
660	147	0	1,015	355	2.42	34.8	453	19.50	Good
	208	+61	1,135	475	2.28	53.2	538	21.78	Choice
				Choice Yearling Steers					
	111	−85	962	252	2.27	23.3	385	19.36	Good
710	196	0	1,126	416	2.12	43.5	465	21.54	Choice
	346	+150	1,383	673	1.94	83.7	618	25.17	Prime
				Good Yearling Heifers (Bred When Purchased)					
	73	−73	798	183	2.49	15.7	476	20.36	Comm.
615	146	0	908	293	2.01	25.8	492	21.83	Good
	203	+57	1,126	411	2.03	39.7	541	22.97	Choice
				Good Yearling Heifers (Open)					
	80	−65	687	162	2.01	9.7	337	16.30	Comm.
525	155	0	704	279	1.79	23.2	466	20.39	Low Good
	204	+49	883	358	1.76	32.5	492	21.10	Good
				Good Two-Year-Old Steers					
	28	−68	826	81	2.85	5.4	337	12.11	Comm.
745	96	0	976	231	2.41	23.5	568	19.48	Good
	200	+104	1,102	447	2.23	50.9	713	24.10	Choice

* Illinois Experiment Station, unpublished data, 1946–1953.

† Feed prices Corn, $1.50 per bu.; protein concentrate, $90 per ton; clover hay, $20 per ton; corn silage, $12 per ton.

Table 103. In these experiments the steer calves that were selected as probable good gainers made larger and cheaper gains and sold for a higher price when marketed than the calves that showed less promise at the time they were started on feed. As a result they were much more profitable. The buyer who can go into a drove of 100 steers and sort out the best 50 or 60 head has a big advantage over the man who is satisfied with a "gate cut" of the number he desires to buy. Most unfortunate is the man who arrives on the scene after the selected cattle have been shipped and, in the absence of any better cattle in the yards, buys the "culls" at a price only a little below that paid for the top end of the drove.

So difficult is it to select feeder cattle, especially when one buys only

Table 103

RESULTS OF SELECTING FEEDER CALVES FOR FACTORS INDICATING RAPID AND ECONOMICAL GAINS

Selected to be	First Test, 1946–1947, 209 Days*		Second Test, 1947–1948, 224 Days†		Third Test, 1948–1949, 190 Days‡	
	Probable Good Gainers	Probable Poor Gainers	Probable Good Gainers	Probable Poor Gainers	Probable Good Gainers	Probable Poor Gainers
Average initial weight, pounds	454	383	455	373	492	403
Average final weight, pounds	825	706	888	757	874	788
Average total gain, pounds	371	323	433	384	382	385
Average daily gains, pounds	1.77	1.54	1.93	1.71	2.01	2.03
Average daily ration, pounds						
Ground shelled corn	9.5	9.1	9.4	8.7	9.9	9 3
Cottonseed meal	1.3	1.3	1.2	1.2	1.8	1.8
Atlas sorgo silage	10.5	7.6	13 5	7.5	8 9	8 0
Hay (alfalfa and prairie)	1.3	0 9	3.1	2.6	2.5	2.5
Feed per cwt. gain, pounds						
Ground shelled corn	534	591	488	510	491	457
Cottonseed meal	74	85	63	72	91	90
Atlas sorgo silage	592	489	700	436	444	394
Alfalfa hay	71	56	161	153	126	126
Selling price per cwt	\$31.00*	\$30 50*	\$31 00*	\$30 50*	\$26 00	\$25 00
Margin per head above feed costs	\$73 02*	\$53 05*	\$73 02*	\$53 05*	\$24.20	\$20.59

* Kansas Experiment Station, Mimeographed Report, 1948.
† Kansas Circular 250, May 7, 1949
‡ Kansas Circular 265, May 6, 1950.
* Average of 1946 1947 and 1947 1948 tests.

one or two droves a year, that few feeders trust their own ability to buy the cattle they need. Instead they place their orders with a commission company at the market where cattle of the weight and grade desired are most likely to be available and leave the details of selection to men who are experts both in the selection of feeder cattle and in bargaining for lower prices. The skill of such men in recognizing unthrifty steers by the carriage of the ears or the expression of the eyes usually results in culling 2 or more animals from the drove which would be poor-doers if purchased. Often the ability of a buyer in detecting cattle that have taken on an abnormal "fill" and his insistence on a substantial reduction in price to offset the excess weight saves his client several times the modest fee charged for his services.

chapter 15
ENERGY IN THE FINISHING RATION

The principal difference between finishing rations, or those fed to cattle being readied for slaughter, and those fed to cows or to stockers is in their energy content. Improvement in condition or finish is the principal aim in finishing programs, although, of course, growth is taking place at the same time, especially in the calf finishing programs. Corn, grain sorghum, and barley are the principal high-energy feeds used in finishing rations, but in some localities other sources of energy, such as molasses, are of some importance. In this discussion the term "grain" is generally used in speaking of "energy" feeds because its meaning is more fully understood. High-energy feeds are also quite generally referred to as carbonaceous concentrates because of their high carbohydrate content as contrasted to protein concentrates, which are so termed because of their above average protein or nitrogen content. It should be mentioned that, generally speaking, protein concentrates, especially the oilseed meals, are also quite high in energy content.

Nearly all cattle marketed from the conventional cattle feeding areas and from commercial feed yards have been fed at least enough grains or other high-energy feeds to permit them to qualify as grain-fed cattle. Such cattle are valued considerably higher than grass-fattened animals by market buyers; consequently it usually is profitable to give cattle at least a short feed of high-energy feeds before they are shipped. The amount of grain to feed a particular drove of cattle depends upon the prevailing prices of grain and roughage (including pasture) and upon the premium being paid for additional finish on the grade of cattle being fed

Full Feed Defined. Most of the cattle finished for market are given a full feed of grain during part of the feeding period On some farms the cattle are placed on a full feed as quickly as possible, perhaps within 2 or 3 weeks after they are put into the feed lot, on others a

full feed of grain is fed during only the last month before the cattle are sold.

Opinions differ as to what constitutes a full feed of grain. Most feeders consider cattle to be on a full feed when they are fed all the grain they want to eat. Yet, if they are also fed all the good-quality legume hay and corn silage they want, they can be induced to eat still more grain by limiting the roughage to what they will clean up readily. A good example of such a ration is that of the full-fed lot in Table 111. Many feeders would not consider 12 pounds of shelled corn to be a full feed for 2-year-old cattle that averaged 950 pounds when they were put into the feed lot. Yet it was as much corn as the Indiana steers would eat along with 31 pounds of silage and approximately 3 pounds of hay. Had the silage been limited to 20 pounds a day, the average daily consumption of shelled corn probably would have been 16 or 17 pounds. Or if no silage at all had been fed, but only 6 or 7 pounds of hay, the steers probably would have eaten 18 or 19 pounds of shelled corn as an average for the whole feeding period. If only 12 pounds of corn is considered a full feed in the Indiana experiment, what term should be given to the larger amounts which the cattle would have eaten if less roughage had been fed?

It is therefore highly desirable that the term "full feed" be defined more accurately than by saying simply that it is the amount of grain that cattle will eat. The term "full feed" may be applied to the roughage part of the ration as well as the grain. If the grain and hay were limited but the cattle were fed all the corn silage they would eat, we would then say they were given a *full feed* of silage. However, when not otherwise indicated, the term refers to a full feed of grain. The amount of grain that cattle will eat varies much too widely for the term to have much value to the inexperienced feeder who is attempting to feed his cattle in accordance with approved practices. A much better way to define the term would be to state the amount of grain they *should eat* if they are to be regarded as full-fed cattle. With this thought in mind we shall define a *minimum full feed of grain* as being 1.5 pounds daily per 100 pounds live weight, including the grain in any corn silage that is fed. Anything over this amount is, of course, a full feed without qualification. However, the feeding of more than 2.0 pounds of grain daily per 100 pounds live weight is a practice of doubtful merit, except for short-fed cattle, since a very heavy consumption of concentrates during the early and middle parts of the feeding period is likely to "burn out" the cattle and result in sluggish appetites and very low gains toward the end. The Iowa calves in Table 104 are a good example of cattle that were fed too

Table 104

FEED EATEN PER 100 POUNDS LIVEWEIGHT BY CATTLE OF DIFFERENT AGES

	First Month	Second Month	Third Month	Fourth Month	Fifth Month	Sixth Month	Seventh Month	Eighth Month	Ninth Month	Average Total Period
Shelled Corn										
Calves										
Iowa[a]	1.6	1.8	1.8	1.8	1.8	1.6	1.4	1.2	1.2	1.6
Indiana[b]	1.3	1.5	1.5	1.6	1.8	1.7	...	...	...	1.6
Nebraska[c]	*	*	*	*	*	*	*	...	...	1.9
Morrison[d]	*	*	*	*	*	*	*	...	...	1.7
Yearlings										
Iowa	1.4	1.8	1.7	1.6	1.5	1.4	1.3	...	...	1.6
Indiana	1.3	1.7	1.7	1.7	1.6	1.6	...	...	...	1.6
Nebraska	*	*	*	*	*	*	*	...	...	1.8
Morrison	*	*	*	*	*	*	...	...	...	1.7
2-year-olds										
Iowa	1.3	1.9	1.7	1.7	...	...	...	...	...	1.7
Indiana	1.1	1.5	1.5	1.7	1.6	1.5	...	...	...	1.5
Nebraska	*	*	*	*	*	*	*	...	...	1.6
Morrison	*	*	*	*	*	...	...	...	...	1.6
Total air-dry feed										
Calves										
Iowa	2.6	2.6	2.6	2.5	2.4	2.4	2.1	1.9	1.8	2.3
Indiana	2.7	2.7	2.6	2.5	2.4	2.3				2.5
Nebraska	*	*	*	*	*	*	*	...	...	2.6
Morrison	*	*	*	*	*	*	*	...		2.5
Yearlings										
Iowa	2.7	2.7	2.6	2.4	2.2	2.1	1.9	...		2.4
Indiana	2.9	2.7	2.6	2.5	2.2	2.1	...			2.4
Nebraska	*	*	*	*	*	*	*		...	2.4
Morrison	*	*	*	*	*	*	...	...		2.5
2-year-olds										
Iowa	2.4	2.6	2.3	2.1			...			2.4
Indiana	2.6	2.5	2.4	2.4	2.2	1.9				2.3
Nebraska	*	*	*	*	*	*	*			2.2
Morrison	*	*	*	*	*	*				2.4

[a] Iowa Bulletin 271.
[b] Indiana Bulletin 136.
[c] Nebraska Bulletin 229.
[d] Morrison, *Feeds and Feeding*, 21st edition, p. 799.
* Monthly amounts not reported

Table 104

FEED EATEN PER 100 POUNDS LIVEWEIGHT BY CATTLE OF DIFFERENT AGES

	First Month	Second Month	Third Month	Fourth Month	Fifth Month	Sixth Month	Seventh Month	Eighth Month	Ninth Month	Average Total Period
Shelled Corn										
Calves										
Iowa[a]	*1.6*	*1.8*	*1.8*	*1.8*	*1 8*	*1 6*	*1.4*	*1.2*	*1.2*	*1 6*
Indiana[b] ..	1 3	1.5	1 5	1 6	1.8	1 7	...	...	. .	1.6
Nebraska[c]. ...	*	*	*	*	*	*	*	...	.	1 9
Morrison[d]. ...	*	*	*	*	*	*	*	..	. .	1 7
Yearlings										
Iowa	1.4	1 8	1.7	1 6	1.5	1 4	1.3	...	...	1 6
Indiana.	1 3	1.7	1.7	1 7	1.6	1.6	. .	...	...	1 6
Nebraska.. ..	*	*	*	*	*	*	*	. .	..	1.8
Morrison	*	*	*	*	*	*	...	...	...	1.7
2-year-olds										
Iowa. ..	1 3	1 9	1 7	1 7	.		...	..	...	1 7
Indiana . ..	1.1	1 5	1 5	1 7	1 6	1 5	...	...	..	1 5
Nebraska . .	*	*	*	*	*	*	*	...	.	1 6
Morrison.. .	*	*	*	*	*	..	...	. .	.	1 6
Total air-dry feed										
Calves										
Iowa	2 6	2 6	2 6	2 5	2 4	2 4	2 1	1 9	1 8	2.3
Indiana.. . .	2 7	2 7	2 6	2 5	2 4	2 3				2 5
Nebraska ...	*	*	*	*	*	*	*	.		2 6
Morrison. ..	*	*	*	*	*	*	*	. .		2 5
Yearlings										
Iowa	2 7	2 7	2 6	2.4	2 2	2 1	1 9			2 4
Indiana .	2 9	2 7	2 6	2 5	2 2	2 1	..	.		2 4
Nebraska	*	*	*	*	*	*	*		.	2 4
Morrison	*	*	*	*	*	*	.	.		2 5
2-year-olds										
Iowa	2 4	2 6	2 3	2 1			..		.	2 4
Indiana	2 6	2 5	2 4	2 4	2 2	1 9				2 3
Nebraska	*	*	*	*	*	*	*			2 2
Morrison	*	*	*	*	*	*				2 4

[a] Iowa Bulletin 271
[b] Indiana Bulletin 136.
[c] Nebraska Bulletin 229
[d] Morrison, *Feeds and Feeding*, 21st edition, p 799.
* Monthly amounts not reported

full feed of grain is fed during only the last month before the cattle are sold.

Opinions differ as to what constitutes a full feed of grain. Most feeders consider cattle to be on a full feed when they are fed all the grain they want to eat. Yet, if they are also fed all the good-quality legume hay and corn silage they want, they can be induced to eat still more grain by limiting the roughage to what they will clean up readily. A good example of such a ration is that of the full-fed lot in Table 111. Many feeders would not consider 12 pounds of shelled corn to be a full feed for 2-year-old cattle that averaged 950 pounds when they were put into the feed lot. Yet it was as much corn as the Indiana steers would eat along with 31 pounds of silage and approximately 3 pounds of hay. Had the silage been limited to 20 pounds a day, the average daily consumption of shelled corn probably would have been 16 or 17 pounds. Or if no silage at all had been fed, but only 6 or 7 pounds of hay, the steers probably would have eaten 18 or 19 pounds of shelled corn as an average for the whole feeding period. If only 12 pounds of corn is considered a full feed in the Indiana experiment, what term should be given to the larger amounts which the cattle would have eaten if less roughage had been fed?

It is therefore highly desirable that the term "full feed" be defined more accurately than by saying simply that it is the amount of grain that cattle will eat. The term "full feed" may be applied to the roughage part of the ration as well as the grain. If the grain and hay were limited but the cattle were fed all the corn silage they would eat, we would then say they were given a *full feed* of silage. However, when not otherwise indicated, the term refers to a full feed of grain The amount of grain that cattle will eat varies much too widely for the term to have much value to the inexperienced feeder who is attempting to feed his cattle in accordance with approved practices. A much better way to define the term would be to state the amount of grain they *should eat* if they are to be regarded as full-fed cattle. With this thought in mind we shall define a *minimum full feed of grain* as being 1.5 pounds daily per 100 pounds live weight, including the grain in any corn silage that is fed. Anything over this amount is, of course, a full feed without qualification. However, the feeding of more than 2.0 pounds of grain daily per 100 pounds live weight is a practice of doubtful merit, except for short-fed cattle, since a very heavy consumption of concentrates during the early and middle parts of the feeding period is likely to "burn out" the cattle and result in sluggish appetites and very low gains toward the end. The Iowa calves in Table 104 are a good example of cattle that were fed too

Table 104

FEED EATEN PER 100 POUNDS LIVEWEIGHT BY CATTLE OF DIFFERENT AGES

	First Month	Second Month	Third Month	Fourth Month	Fifth Month	Sixth Month	Seventh Month	Eighth Month	Ninth Month	Average Total Period
Shelled Corn										
Calves										
Iowa[a]	1.6	1 8	1.8	1.8	1 8	1.6	1 4	1.2	1.2	1.6
Indiana[b]	1.3	1.5	1 5	1.6	1.8	1 7	...	...	. .	1 6
Nebraska[c]	*	*	*	*	*	*	*	...	..	1 9
Morrison[d]	*	*	*	*	*	*	*	..	.	1 7
Yearlings										
Iowa	1.4	1 8	1 7	1.6	1.5	1 4	1 3	...	.	1.6
Indiana	1 3	1.7	1.7	1 7	1.6	1.6	. .	...	...	1 6
Nebraska	*	*	*	*	*	*	*	. .	..	1.8
Morrison	*	*	*	*	*	*	..	...	..	1 7
2-year-olds										
Iowa	1.3	1 9	1 7	1 7		.	...	..	...	1 7
Indiana	1 1	1.5	1 5	1 7	1 6	1.5	...	...	..	1 5
Nebraska	*	*	*	*	*	*	*	...	.	1 6
Morrison	*	*	*	*	*	...	.	. .	. .	1 6
Total air-dry feed										
Calves										
Iowa	2.6	2.6	2 6	2 5	2 4	2 4	2 1	1 9	1 8	2 3
Indiana	2 7	2 7	2 6	2 5	2 4	2 3	.			2 5
Nebraska	*	*	*	*	*	*	*	.	.	2 6
Morrison	*	*	*	*	*	*	*	.		2 5
Yearlings										
Iowa	2 7	2 7	2 6	2 4	2 2	2 1	1 9	.		2 4
Indiana	2 9	2 7	2 6	2 5	2 2	2 1	.	.		2 4
Nebraska	*	*	*	*	*	*	*		. .	2 4
Morrison	*	*	*	*	*	*	.	.		2 5
2-year-olds										
Iowa	2 4	2 6	2 3	2 1			.			2 4
Indiana	2 6	2 5	2 4	2 4	2 2	1 9				2 3
Nebraska	*	*	*	*	*	*	*			2 2
Morrison	*	*	*	*	*	*				2 4

[a] Iowa Bulletin 271.
[b] Indiana Bulletin 136.
[c] Nebraska Bulletin 229
[d] Morrison, *Feeds and Feeding*, 21st edition, p. 799.
[e] Monthly amounts not reported

much corn during the first half of the feeding period. Whereas they averaged 10.2 pounds of corn per day during the third month and 13 pounds during the sixth, their average consumption was only 10.2 pounds during the eighth month and 11.2 pounds during the ninth.

After cattle have been got on a full feed they should be kept there until they are marketed. Consequently it is highly important that they be fed so that their consumption of grain does not fall below 1.5 pounds per 100 pounds live weight, even during the last month they are on feed. This stability can be achieved only if they are not placed on full feed too quickly and if the amount of grain consumed daily is not allowed to exceed 2.00 pounds per 100 pounds live weight. Excess is avoided by feeding enough good palatable roughage to keep the grain consumption at or slightly below this level.

How Much Feed Will Cattle Eat? The previous discussion as to what constitutes a full feed of grain has brought out the fact that the amount of corn or roughage eaten can be controlled by increasing or decreasing the other components of the ration. If cattle are being fed principally to utilize roughage, the grain is fed in limited amounts in order to induce the cattle to consume large quantities of roughage. But if the purpose of feeding is to market as much grain through cattle as possible, it is roughage that is limited. This leads to the questions as to how much total feed cattle eat, and what is the replacement value of roughage in terms of grain.

A study of the lower half of Table 104 discloses that the total air-dry feed eaten per 100 pounds live weight decreases gradually during the grain feeding period. During the first quarter it is about 2.7 pounds; during the last quarter it is often little more than 2.0 pounds per 100 pounds live weight. However, this does not mean that the daily consumption of feeds has declined. Rather it has constantly increased, because the cattle have increased in weight faster than their feed intake per unit of weight has diminished.

Between cattle of different ages the differences in the feed consumption per 100 pounds live weight are too small to be of practical importance. It will be noted in Table 104 that the Iowa calves were grain-fed for 9 months, which is about 1 month longer than most calves are fed. Had they been marketed after 8 months their average daily consumption of feed for the total period would have been 2.4 pounds. On the other hand, the Indiana calves were fed for only 6 months. Had they been fed 2 months longer their daily consumption of both corn and hay probably would have been about 2.4 pounds per 100 pounds live weight. In referring to the 2-year-old steers we note

that both the Indiana and Nebraska steers were fed somewhat longer than most cattle of this age. Had they been fed only 5 months it seems reasonable to believe that their average total feed consumption per 100 pounds live weight would also have been close to 2.4 pounds. Consequently 2.4 pounds per 100 pounds live weight appears to be a good figure to use in estimating the average daily total feed consumption of cattle that are fed a full feed of grain after about the first month or 6 weeks of the feeding period. The approximate consumption during different parts of the feeding period may be obtained by assuming the total air-dry feed to be 2.7, 2.5, 2.3, and 2.1 per cent of the live weight for the first, second, third, and last quarters of the feeding period, respectively. These figures, of course, are on the assumption that calves are fed grain for approximately 250 days, yearlings 200 days, and 2-year-old steers 150 days. For cattle fed a shorter time the estimates for the last quarter should be disregarded; and for a feeding period of only one-half the usual length, only 2.7 and 2.5 per cent apply. If it is desired to make month-by-month estimates of the grain or total feed consumed daily, the monthly averages given in Table 104 may be used.

It will be noted that in discussing a full feed of grain and the total feed consumed daily, no mention has been made of the amount of protein concentrate fed. This item of the ration has been intentionally omitted from the discussion, since the feeding of 1 to 2 pounds of protein supplement has no significant depressing effect upon the amount of grain and roughage consumed (see Table 140). Consequently it may be ignored in estimating the amount of grain required for a full feed and the total air-dry feed required to satisfy the appetites of full-fed cattle.

Replacement Value of Roughage. It appears from the data in Table 105 that grain and air-dry roughage are interchangeable on a pound-for-pound basis for cattle that are fed at least half of a minimum full feed of grain. The replacement value of silage in terms of grain is more difficult to determine for the reason that it varies greatly in moisture content. However, if we assume that the air-dry roughage equivalent of silage is 33⅓ per cent of the weight fed, we find that grain and silage replace each other on an air-dry basis within the limits of practical error.

A Simple Method for Estimating Feed Required to Finish Cattle. The factors that have been developed in the preceding paragraphs in regard to the feed consumption of finishing cattle have much value in estimating the amount of grain and roughage required to finish a given drove of cattle. These factors are also useful in checking the ration at

Table 105

REPLACEMENT VALUE OF GRAIN AND ROUGHAGE IN THE DAILY RATION OF FEEDER CATTLE

Replacement Made	Average Weight During Experiment (pounds)	Average Daily Ration			Average Total Air-Dry Feed per Day (pounds)[a]	Time Fed (days)	Air-Dry Feed per 100 Pounds Live Weight (pounds)
		Grain (pounds)	Hay (pounds)	Silage (pounds)			
1 Grain replaced by hay							
Nebraska Bull 116							
Heavy feed of grain	1200	19.9	8.8	....	28.7	84	2.50
Medium feed of grain	1156	17.2	9.7	....	26.8	84	2.33
Light feed of grain	1124	12.0	14.0	....	26.0	84	2.31
Nebraska Bull. 355							
Heavy feed of grain	1028	16.4	9.7	..	26.1	140	2.54
Medium feed of grain	1039	14.0	12.6	....	26.6	140	2.56
Light feed of grain	1042	12.1	15.5	....	27.6	140	2.65
Ohio Bull 198							
Full feed of corn	923	13.3	3.2	13.7	22.0	240	2.38
⅔ feed of corn	914	10.1	6.2	14.1	21.7	240	2.39
⅓ feed of corn	889	6.7	8.7	14.2	21.1	240	2.37
2 Grain replaced by silage							
Kansas Mimeo 45-B-1							
Full feed of barley	936	14.0	....	17.8	21.2	180	2.27
⅔ feed of barley	916	9.4	....	33.6	22.8	180	2.49
⅓ feed of barley	909	4.7		41.8	21.4	180	2.36
Iowa Mimeo AH 162							
Full feed of corn	900	13.2	1.1	17.7	21.4	175	2.38
½ feed of corn	862	6.4	1.1	32.3	20.4	175	2.37
Indiana[b]							
Full feed of corn	1115	11.9	3.0	31.5	27.5	139	2.46
½ feed of corn	1093	6.1	3.5	39.9	25.6	139	2.34

[a] Air-dry weight of silage assumed to be 40 per cent of weight of silage fed.
[b] See Table 111 for Indiana results in more detail.

different stages of the feeding period to see whether grain and roughage are being fed in about the required amounts. The following example shows how these factors are used.

Given 30 steers, weighing 700 pounds when purchased, which are to be fed to choice finish. How much shelled corn or sorghum and hay are needed?

Solution

Estimated time to be fed, 180 days.

Estimated average daily gain, 2.25 lb.

Calculated final weights, 700 + (180 × 2.25) lb. = 1,105 lb.
Calculated average weight (700 + 1,105)/2 = 900 lb.
Total feed required daily per 100 lb. live weight = 2.4 lb.
Total feed required daily per head, 2.4 lb. × 9 = 21.6 lb.
Total feed required daily by 30 steers, 30 × 21.6 = 648 lb.
Average grain eaten daily per 100 lb. live weight by cattle on full feed, 1.6 lb.
Average grain eaten daily by 900-lb. cattle, 9 × 1 6 = 14.4 lb.
Average grain eaten daily by 30 cattle, 30 × 14 4 = 432 lb.
Average hay eaten daily by 30 cattle = 648 − 432 = 216 lb.
Average hay eaten daily per steer = 216/30 = 7 lb.
Estimated total grain needed for 180 days = 180 × 432 = 77,760 lb. = 1,400 bu. corn or 1,620 bu. sorghum
Estimated hay needed for 180 days = 180 × 216 = 38,880 lb. = 20 tons.

Similarly, if it is desired to know how much grain and hay are needed during the last month of the feeding period, a close estimate may be made by assuming that approximately 2 pounds of grain and hay combined will be eaten daily per 100 pounds live weight. About 1.5 pounds of this amount will be grain and 0 5 pound will be hay (See Table 106.) Multiplying these quantities by the estimated weight of the cattle and dividing the results by 100 gives the approximate average daily consumption of grain and hay during the last month of the feeding period.

The amount of silage required in this example could be determined by increasing the daily hay consumption three times, or by dividing it by the factor 0 33. Because of the palatable nature of silage the

Table 106

AVERAGE AMOUNTS OF FEED CONSUMED BY FULL-FED CATTLE DURING DIFFERENT PARTS OF THE FEEDING PERIOD*

	Feed per 100 Pounds Live Weight		
Quarter of Feeding Period	Total Air-Dry Feed (pounds)	Grain (pounds)	Air-Dry Roughage (pounds)
1. First	2 7	1.5	1 2
2. Second	2.5	1.7	0.8
3. Third	2 3	1.6	0 7
4 Last	2 1	1 5	0 6
Average for entire period	2.4	1 6	0 8

* Average length of grain feeding period: 2-year-old steers, 150 days; yearlings, 200 days; calves, 250 days

grain contained in the silage will be consumed without reducing the regular grain consumption to any great extent.

Nutrient Requirements of Feeder Cattle. The simple rules of thumb just discussed for estimating total feed and energy requirements and those for protein requirements which will be discussed in Chapter 17 simply serve as guides in the formulation of rations and in determining the total feed requirements of a drove of feeder cattle. For those who wish to formulate rations more exactly, or for those who wish to feed a complete mixed ration, Tables 107 and 108 give the National Research Council requirements for feeder calves, yearlings, and 2-year-old cattle. As in the previous NRC tables, ration requirements are shown both on a daily requirement basis and a percentage composition basis. Morrison's standards are shown in Table 109.

Getting Cattle on Feed. Comparatively few of the feeder cattle shipped into the feed lots from the range states have been fed any grain. Consequently they must be taught to eat it. Teaching can be accomplished easily by putting about a pound of grain per head in the feed trough and feeding 4 to 6 pounds of hay on top of it. In eating the leaves and chaff from the bottom of the trough, the cattle also pick up the grain and quickly learn to eat it. If it is desired to get the cattle on a full feed of grain rather promptly, the grain should be increased by about 1 pound per head daily until they are eating 1 pound of grain per 100 pounds live weight, after which time increases of 1 pound a head every third day for 2-year-old steers, ½ pound every third day for yearlings, and ¼ pound every third day for calves are recommended, as shown in Table 110. All this time, of course, the cattle should have as much roughage in the form of hay or silage as they will eat. If all the cattle do not appear hungry when they are fed, the hay or silage should be reduced enough to insure that all animals come to the feed trough promptly and begin eating when the grain is fed.

If the grain ration is increased gradually as suggested above, 2-year-old cattle attain a minimum full feed of grain (1.5 per cent of their live weight) about 30 days after they have been started on feed, yearlings in about 40 days, and calves in about 50 days. Further increases, of course, should be made as the cattle increase in weight and become better adjusted to a heavy feed of grain.

Obviously the weight of the cattle increases more rapidly than their capacity for feed. Consequently it usually is necessary to reduce the roughage from time to time in order to maintain the level of grain consumption at at least 1.5 per cent of the live weight. (Calves, because of their rapid growth, may increase in size sufficiently to

Table 107

Daily Nutrient Requirements of Feeder Cattle*

(Based Upon Air-Dry Feed Containing 90 Per Cent Dry Matter)

Body Weight (lb.)	Av. Daily Gain (lb.)	Daily Feed per Animal (lb.)	Daily Requirement per Animal: Total Protein (lb.)	Digestible Protein (lb.)	Total Digest. *Nutrients* (lb.)	Digestible *Energy* (therms)	Calcium (gm.)	Phosphorus (gm.)	Carotene (mg.)	Vitamin A, I. U. × 1,000
					Finishing Calves Finished As Short Yearlings					
400	2.3	12	1.3	1.0	8.0	16	20	15	7	2.8
600	2.4	16	1.8	1.3	10.9	22	20	17	10	4.0
800	2.2	20	2.0	1.5	13.6	27	20	18	14	5.6
1,000	2.2	22	2.2	1.6	15.0	30	20	20	17	6.8
					Finishing Yearling Cattle					
600	2.4	18	1.8	1.4	11.7	23	20	17	10	4.0
800	2.8	22	2.2	1.6	14.3	29	20	20	14	5.6
1,000	2.5	26	2.6	2.0	16.9	34	20	24	17	6.8
1,100	2.3	27	2.7	2.0	17.6	35	20	25	19	7.6
					Finishing Two-Year-Old Cattle					
800	2.8	24	2.4	1.8	14.9	30	20	22	14	5.6
1,000	3.0	27	2.7	2.0	16.7	33	20	25	17	6.8
1,200	2.6	29	2.9	2.2	18.0	36	20	26	20	8.0

* *Nutrient Requirements of Beef Cattle*, Sub-Committee on Beef Cattle Nutrition, *National Research Council*, revised edition, 1958.

Table 108

Nutrient Requirements of Feeder Cattle Expressed as Percentage Composition of Air-Dry Rations*

Body Weight (lb.)	Av. Daily Gain (lb.)	Daily Feed per Animal (lb.)	Total Protein (%)	Digestible Protein (%)	Total Digest. Nutrients (%)	Digest. Energy (therms per lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg. per lb.)	Vitamin A (I.U. per lb.)
			Requirement as Per Cent of Ration or Amount per Pound of Feed							
Finishing Calves Finished as Short Yearlings										
400	2.3	12	11.0	8.2	67	1.33	0.37	0.28	0.6	240
600	2.1	16	11.0	8.2	68	1.36	0.28	0.23	0.6	240
800	2.2	20	10.0	7.5	68	1.36	0.22	0.20	0.7	280
1,000	2.2	22	10.0	7.5	68	1.36	0.20	0.20	0.8	320
Finishing Yearling Cattle										
600	2.4	18	10.0	7.5	65	1.30	0.25	0.21	0.6	240
800	2.8	22	10.0	7.5	65	1.30	0.20	0.20	0.6	240
1,000	2.5	26	10.0	7.5	65	1.30	0.17	0.20	0.7	280
1,100	2.3	27	10.0	7.5	65	1.30	0.16	0.20	0.7	280
Finishing Two-Year-Old Cattle										
800	2.8	24	10.0	7.5	62	1.24	0.18	0.20	0.6	240
1,000	3.0	27	10.0	7.5	62	1.24	0.16	0.20	0.6	240
1,200	2.6	29	10.0	7.5	62	1.24	0.15	0.20	0.7	280

* *Nutrient Requirements of Beef Cattle*, Sub-Committee on Beef Cattle Nutrition, National Research Council, revised edition, 1958.

Table 109

MORRISON'S FEEDING STANDARDS FOR FINISHING CATTLE*

Class of Cattle and *Weight* (lb)	Requirements per Head Daily: Dry *Matter* (lb.)	Digestible *Protein* (lb.)	Total Digestible Nutrients (lb)	*Calcium* (gm)	(lb.)	Phosphorus (gm)	(lb)	Carotene (mg)
Calves finished for baby beef								
400	9.6–12.1	1.05–1.15	7.4– 8 6	20	0.044	15	0 033	25
500	11.3–13 8	1 14–1.26	8 8–10 2	20	0 044	16	0 035	30
600	13.2–15.8	1.26–1.37	10 2–11.8	20	0 044	17	0 037	35
700	14.8–17.5	1.39–1.52	11.6–13.2	20	0 044	18	0 040	40
800	16.7–19.3	1.52–1.68	12 6–14 4	20	0 044	18	0 040	45
900	*17.7–20.3*	*1.64–1.82*	*13 5–15.5*	*20*	*0.044*	*18*	*0 040*	*50*
Finishing yearling cattle								
600	15 0–17.6	1.18–1 32	10.7–12.3	20	0 044	17	0.037	35
700	16 5–19 1	1.36–1 52	12.7–14 3	20	0 044	18	0 040	40
800	17.8–20.4	1.52–1 68	14.1–15 9	20	0 044	19	0.042	45
900	18.9–21.7	1.64–1.82	15 4–17.2	20	0 044	20	0 044	50
1,000	20.0–23 0	1.71–1.91	16.0–18 0	20	0 044	20	0 044	55
1,100	21.0–24.0	1.76–1.96	16 5–18.5	20	0 044	20	0.044	60
Finishing 2-year-old cattle								
800	*19.6–22.2*	*1.46–1 62*	*14.1–15 9*	*20*	*0 044*	*20*	*0 044*	*45*
900	20.7–23.5	1 53–1.78	14 6–17 4	20	0 044	20	0 044	50
1,000	*22.0–25 0*	*1.65–1.85*	*16.5–18 5*	*20*	*0 044*	*20*	*0 044*	*55*
1,100	24 0–27.0	1.70–1 90	17 0–19 0	20	0 044	20	0 044	60
1,200	24 0–27.0	1.70–1 90	17.0–19 0	20	0 044	20	0 044	65

* Taken by permission of *The Morrison Publishing Co., Ithaca, N Y., from Feeds and Feeding*, 22nd edition, by Frank B. Morrison.

permit appropriate increases of grain without reducing the roughage below the amount they were eating when they attained a minimum full feed.) However, the reduction of the roughage to a weight below 0.5 per cent of the live weight is seldom justified, since further decreases in the roughage usually have little effect upon the consumption of grain. In calculating the consumption of roughage the cobs in corn-and-cob meal and the estimated dry weight of the stover in corn silage should, of course, be considered as air-dry roughage.

Full vs. Limited Grain Rations. Although the general practice among cattle feeders is to get their cattle on a full feed of grain within

Table 110

SUGGESTED SCHEDULE OF GRAIN FEEDING TO GET CATTLE SAFELY ON A FULL FEED

Day	2-Year-Olds			Yearlings			Calves			Actual Record of 373-Pound Calves*	
	Shelled Corn (lb)	Average Weight (lb.)	Corn per 100 (lb)	Shelled Corn (lb.)	Average Weight (lb.)	Corn per 100 (lb.)	Shelled Corn (lb.)	Average Weight (lb.)	Corn per 100 (lb.)	Shelled Corn (lb.)	Corn per 100 (lb.)
1	1	900		1	700		1	425		3 0	
2	2			2			2			4.4	
3	3			3			3			5.5	
4	4			4			4			6 4	
5	5			5			4			7.3	
6	6			6			4			7.5	
7	7			7			4 25			8 0	
8	8			7			4 25			8 25	
9	9			7			4.25			9.25	
10	9	930	0 97	7 50	725	1.0	4 50	450	1.0	9 50	2.4
11	9			7 50			4 50			9 25	
12	10			7 50			4.50			6 4	
13	10			8			4 75			2.5	
14	10			8			4 75			2 5	
15	11			8			4 75			5 6	
16	11			8 50			5			7.75	
17	11			8 50			5			8 38	
18	12			8 50			5			9.13	
19	12			9			5 25			9 75	
20	12			9			5 25			8 00	
21	13			9			5 25			8.00	
22	13	960	1 35	10 50	750	1 40	5 50	465	1.2	5 00	1.2

* Iowa Bulletin 271 These calves were gotten on feed too rapidly and went off feed badly on the twelfth day and again on the twenty-second day.

30 to 50 days, it is sometimes decided to limit the grain to a smaller amount and feed more than the usual amounts of roughage. This plan of feeding is likely to be popular during years when grain is in short supply and high in price and roughage is plentiful and cheap, and also during periods when, because of an abnormally strong demand for beef, a narrow price spread prevails between well-finished cattle and those marketed in lower condition. Such a situation prevailed during both World War I and World War II, with the result that a large percentage of the cattle fed during the war years were given somewhat less than a full feed of grain.

The extent to which the grain ration is limited depends principally upon (1) the relative supply of grains and roughages, (2) the kind and quality of the roughage, and (3) the length of the feeding period.

If plenty of corn or sorghum silage is available, the grain may be limited to only the grain that is in the silage, since cattle make fairly good gains on a full feed of such silages, plus 2 to 4 pounds of legume hay, and about 2 pounds of a protein concentrate per head daily. If the principal roughage fed is hay, at least one-half of a full feed of grain must be fed if satisfactory gains and finish are to be secured.

Usually the most satisfactory way to employ limited grain rations in finishing cattle is to feed no grain during the first and second months except the grain in the silage, one-half a full feed during the third and fourth months, and a full feed during the last month. If the cattle are fed longer than 5 months, two-thirds or three-fourths of a full feed may be fed during the fourth month and a full feed thereafter.

Usually better results are obtained by increasing the level of grain feeding from time to time than by maintaining the same level throughout the feeding period. For example, Table 111 summarizes an extensive series of experiments, carried out at the Indiana Experiment Station, in which steers that were fed no corn during the first half

FIG. 68. A heavy feed of corn silage with supplements and limited grain during the preceding winter cheapened the overall cost of gains on these steers being full-fed in dry lot during the summer for the fall market. (Corn Belt Farm Dailies)

Table 111

COMPARISON OF RATIONS CONTAINING DIFFERENT AMOUNTS OF CORN FOR STEERS*
(Two-year-olds)

Average of Seven Years' Work	Full Feed of Corn	One-half Feed of Corn	Full Feed of Corn During Last Half of Period	No Corn
Number of Lots Averaged†	7	7	6	6
Length of Feeding Period (days)	139	139	136.6	136.6
Initial Weight	951 lb.	951 lb.	964 lb.	964 lb.
Total Gain	327.5	283.5	299	259.5
Daily Gain	2.37	2.05	2.17	1.90
Total Feed Consumed (lb.)				
Shelled Corn	1,650	850	745	....
Cottonseed Meal	370	365	365	365
Clover Hay	410	448	525	550
Corn Silage	4,350	5,515	5,665	6,680
Average Daily Feed				
Shelled Corn	11.89	6.13	5.42	....
Cottonseed Meal	2.66	2.64	2.67	2.66
Clover Hay	2.97	3.48	3.81	3.98
Corn Silage	31.54	39.91	41.58	48 99
Feed per lb. Gain				
Shelled Corn	5 05	3.05	2.53	....
Cottonseed Meal	1.14	1.32	1.27	1.44
Clover Hay	1.28	1.73	1.85	2.16
Corn Silage	13 43	19.92	19.91	26.43
Cost per cwt. Gain	$18.67	$18.19	$17.47	$15.63
Initial Value per cwt.	9.03	9 03	9 03	9.03
Necessary Selling Price (in lots)	11.40	11.00	10.86	10 34
Actual Selling Price (in lots)	11.62	11.08	11.125	10.85
Profit per Steer (excluding pork)	3.25	1.13	3.38	6 47
Pork Produced per Steer	45.17	29.41	31.67	−1.43
Profit per Steer, Pork Included	13.87	8.08	9.91	7.95

* Compiled from Indiana Bulletins 191, 206, 220, 240, 249, 255, 265.
† Six lots used in averaging financial results.

of the experiment but a full feed during the last half gave better results than a lot that received one-half a full feed during the whole period.

Effect of Limiting the Grain. (1) *Upon Rate of Gain.* Obviously the rate of gain increases with the level of grain feeding. However, if the amount of grain is gradually increased, so that a full feed is supplied during the last few weeks, the decline in gains usually

observed in full-fed cattle may not occur. Such a decline in gains is especially likely to occur in cattle full fed longer than 200 days, which often show sluggish appetites during the latter part of the feeding period.

(2) *Upon Cost of Gains.* Unless cheaper gains are secured from limiting the grain ration, there can be no advantage from doing it, since it is almost certain that the cattle will sell for less per hundred than they would bring if they were full fed. The fact that the cost of the daily ration is less does not necessarily mean that the gains are cheaper, since the daily gains too are smaller than those of full-fed cattle. Consequently the cost of the gain per hundred made by limited-fed cattle should be checked frequently during the feeding period to see whether the saving in cost of gains during the remainder of the period is enough to offset the markdown in selling price which will probably be encountered by the cattle because of their having been fed less than a full feed of grain.

(3) *Upon Profit Realized.* Cattle fed a limited feed of grain are not always more profitable than those that have been full fed. Indeed, if anything, the reverse is true. Only when the difference in price between well-finished steers and those carrying only a moderate amount of condition is unusually small, is the profit realized per head larger from limited grain feeding. However, the practice may be justified on the basis of numbers fed. For example, if only enough grain is available to supply 30 cattle with a full feed, it furnishes a half feed for 60 head, if there is enough roughage for the larger number. Consequently, limiting the grain would be more profitable than full feeding, even though the profit realized per head on them was only 60 per cent of that made from the cattle that were full fed. Moreover, a cash return has been obtained for a considerable quantity of roughage which would not have been utilized if only 30 cattle had been fed instead of 60.

The Indiana Experiments. Although almost every Corn Belt station has conducted feeding trials involving the use of limited grain rations, those carried on by the Indiana station are so exhaustive as to make a careful study of their results highly desirable. Altogether, the Indiana tests covered 7 years' work and involved the use of some 26 different lots of cattle, or over 250 head in all. Except for the first year, when only 2 lots were used, each trial involved the use of 4 lots of cattle, fed corn as follows:

1. Full feed during entire period
2. One-half feed, based upon consumption of Lot 1.

3. No corn during first part of feeding period; full feed during last part (approximately last half).
4. No corn at all.

In addition to the corn ration, fed as stated above, all lots received cottonseed meal, clover hay, and corn silage. The cottonseed meal was fed at the rate of 2.5 pounds per day per 1,000 pounds live weight, and the clover and silage were supplied according to the appetites remaining after the consumption of the desired amounts of corn. In no test did the full-fed cattle receive an excessive amount of corn, such as is sometimes fed by feeders of the old school. The average ration varied during the 7 years from 9.81 to 13.25 pounds of shelled corn per day for the entire period; the average consumption for the 7 trials was 11.89 pounds. (See Table 111.)

Whereas some variation existed in the Indiana trials during the different years in the effect of the amount of corn fed upon the daily gains secured, in no year did the full-fed lot fail to make the largest, and the no-corn lot the smallest, daily gain.

It should be noted that, as the feeding period progressed the gains made by the no-corn cattle fell off much more rapidly than those for the full-fed lot. The same statement applies to the cattle receiving half a feed of corn, although hardly to the same degree. Such a condition is to be expected with limited grain rations, since the withholding of the grain results in a relatively unpalatable ration which the cattle tire of in time. In the full-fed lots the gains were maintained largely by decreasing the roughage component of the ration and increasing the concentrates. Similar results were obtained by feeding corn during only the latter half of the feeding period.

The Ohio Experiments. The Ohio Experiment Station also conducted a series of feeding trials that demonstrated the importance of limited grain rations for feeders who do not have enough corn to supply a full feed to the number of cattle required to utilize the available roughages. The most noteworthy fact disclosed by these tests, which are summarized in Table 112, is that nearly twice the number of cattle may be fed for a given number of days on a field of corn put into the silo than could be fed if the corn were fed as shelled corn and stover. Whereas cattle that are fed silage and no additional grain often show a smaller profit per steer, they usually return a larger profit per acre because of the greater number fed. Consequently this method of feeding has a real advantage for the feeder who is seeking a way to market a field of corn so that it adds most to the total farm income. Moreover, many small farmers who

Table 112

EFFECT OF LIMITING THE GRAIN RATION UPON THE RETURN REALIZED PER STEER AND PER ACRE OF CORN FED*

	First Trial 174 Days		Second Trial 177 Days		Third Trial 183 Days	
Corn Component	Corn Silage	Shelled Corn Stover	Corn Silage	½ Feed Silage Sh. Corn Stover	Corn Silage	½ Feed Silage Ground Oats
Initial weight, lb.	622	607	662	662	630	632
Av. daily gain	2.01	2.24	2.11	2.51	1.85	2.15
Av. daily ration						
Shelled corn	.	16.3		11.9		11.2†
Prot. conc.	2.0	2.0	2.0	2.0	2.0	
Corn stover		9.5		7.7		
Mixed hay	1.2	1.6	2.8	2.1	2.9	2.8
Corn silage	47.4	.	49.4	24.9	42.0	21.0
Gain of cattle per acre of corn	752	372	712	515	712	236‡
Steer days per acre of corn	375	166	337	205	385	110‡
Selling price of cattle	$14.00	$14.75	$10.60	$11.25	$5.25	$5.50
Profit per steer	8.58	3.46	11.79	13.69	−5.86	−4.83
Return per acre of corn	71.65	50.80	56.66	57.06		
Yield per acre						
Silage, tons	8.8		8.8	8.8	8.3	8.3
Grain, bushels	(48)	48	(63)	63	(40)	45§

* Ohio Bimonthly Bulletins Nos. 139, 146, 164.
† Ground oats.
‡ Per acre of land in both silage and oats.
§ Yield of oats

are able to feed a limited grain ration to a carload of steers would have sufficient corn to full feed only half that number. The greater number benefit the farm by utilizing a much larger supply of unmarketable roughages and by producing a larger amount of manure for the cultivated fields.

A second series of limited grain experiments conducted by the Ohio station is reported in Table 113. These experiments differed from previous tests just discussed in that large quantities of hay instead of silage were fed to take the place of the corn withheld from the cattle. These tests are of particular value to farmers who are increasing their acreage of alfalfa and other legume hays. Large amounts of hay can be utilized with feeder cattle only by limiting the grain to considerably less than a full feed, so that the cattle are induced to eat it.

A comparison of Tables 112 and 113 brings out the great advantage which corn silage has over legume hay in limited grain rations. Whereas the substitution of silage for part or all of the grain greatly increased the number of cattle that could be finished on a given area, the substitution of legume hay for the grain increased the number only slightly. Of still more importance is the fact that the total gain realized per acre of crops fed to cattle greatly increased with the amount of silage fed, whereas it decreased slowly but steadily with the amount of hay fed. Of course it should be said that legumes must

Table 113

LIMITING THE CORN AND INCREASING THE AMOUNT OF LEGUME HAY IN RATIONS FOR FINISHING YEARLING STEERS*

(Average of 3 tests)

Av. Time Fed, 240 Days	Full Feed of Corn	Three-fourths Full Feed of Corn	One-half Full Feed of Corn
Av. Initial Wt. lbs.	694	694	686
Av. Final Wt lbs.	1152	1133	1091
Av. daily gain	1.91	1.78	1.69
Av daily ration			
Corn-and-cob meal	13.3	10.1	6.7
Prot conc	1.5	1.5	1.5
Corn silage	13.7	14.1	14.2
Clover or alfalfa hay	3.2	6.2	8.7
Feed per cwt. gain			
Corn-and-cob meal	696	564	399
Prot conc	78	83	88
Corn silage	719	790	843
Clover or alfalfa hay	169	347	517
Selling price per cwt.	$12.62	$12.20	$11.83
Acres of feed eaten per head			
Ear corn	.91	.69	.46
Corn silage	.17	.17	.17
Legume hay	.19	.37	.52
Total acres	1.27	1.23	1.15
Ratio of Corn Acreage to Hay Acreage	5.5:1	2.3:1	1.2:1
Cattle gains per acre	367	350	354
Hog gains per acre	20	19	14
Total gains per acre	387	369	368

* Ohio Bimonthly Bulletin 198.

be grown to keep up the fertility of the soil, and also that a large part of the corn grown on many farms is fed to swine. Therefore a limited amount of corn but large quantities of hay are left to be utilized by beef cattle. Where this condition exists, better results are usually realized if all the corn available for the cattle is made into silage and a sufficient number of cattle are purchased to be fed a full feed of silage and 3 or 4 pounds of hay for approximately 150 days. Legumes not needed for hay under this system of feeding may well be plowed under to enrich the soil, thereby saving the expense of harvesting.

Practical Use of Limited Grain Ration. The results of any experimental feeding trial with limited grain rations should not be applied directly to practical feeding operations. In studying such results it should be kept in mind that the different rations were fed to the same grade of cattle and for the same length of time. It is highly necessary from an experimental standpoint that these items be identical in the different lots since in an experiment only one factor may vary. However, great variations exist in these respects in actual feeding operations. Farmers who plan to feed little or no grain seldom, if ever, buy as good a grade of feeder cattle as those men who full feed from the start. To do so would, as a rule, be a waste of money Cattle finished largely on roughage cannot be expected to "top the market." Realizing this, most cattlemen refrain from buying choice or fancy feeders to utilize large quantities of roughage and little grain Since cattle so finished furnish a comparatively low grade of beef, it is manifestly a good practice to start with comparatively low-priced steers.

Since limited grain rations cannot be counted on for satisfactory gain after about 150 days, few feeders use such rations for longer periods. Indeed, the more usual practice is to feed for only 90 to 120 days. With such a short feeding period it is desirable that the cattle have considerable age and size, so that they are likely to make a rapid improvement in condition. Fully matured steers, lacking somewhat in quality and decidedly thin in flesh, but having large frames and good deep middles, are the ideal kind for limited grain rations. Because of their deficient quality and condition they can be bought cheap Moreover, their size and maturity insure a rapid gain in weight and a marked improvement in condition from the large quantities of roughage that they consume.

Another point to be kept in mind in connection with limited grain rations is that such rations are most likely to prove satisfactory during the winter months when the appetites of the cattle are unusually keen

because of the cold weather. At other seasons of the year the consumption of bulky feeds such as silage and hay is not likely to be sufficiently large to produce satisfactory gains in the absence of a liberal amount of grain. Also, the market for plain, half-finished steers such as are produced by the use of such rations is usually much better in the late winter and spring than at any other time of year.

chapter 16
CARBONACEOUS CONCENTRATES AND THEIR USE IN THE FINISHING RATION

From the standpoint of their source, concentrates are of two kinds: (1) the grains of farm-grown crops; and (2) commercially manufactured feeding stuffs. According to their composition, concentrates may be divided into two groups: (1) carbonaceous feeds, or those containing a relatively high percentage of energy and a low percentage of protein, and (2) nitrogenous feeds, or those that are especially rich in protein. In general the farm-grown grains belong in the carbonaceous class, whereas a majority of the commercial feeding stuffs are nitrogenous.

Carbonaceous feeds, as their name implies, are rich in chemical compounds that contain a relatively large amount of carbon. The more important of these compounds are starches, sugars, and fats. All these materials, when consumed by animals, are utilized chiefly for muscular energy and for conversion to body fat, which is stored in various parts of the body, but especially in the superficial layers of muscles found just beneath the skin Consequently, carbonaceous concentrates are of prime importance in finishing cattle for the market.

Carbonaceous concentrates are highly efficient in the production of fat. In addition, because they are produced in great abundance by the farmers themselves, they are relatively cheap Therefore they should, and usually do, form the major portion of the finishing ration

The important carbonaceous concentrates used in cattle feeding are corn, oats, barley, wheat, the grain sorghums, beet pulp, and molasses. Although the use of some of these feeds is limited to certain sections, a brief discussion of all of them will be attempted.

Corn. In corn (*Zea mays*) is found the explanation of the wonderful development attained by the beef cattle industry of the United States. Other countries have cattle of as good or better breeding; other regions have as good or more favorable climate; other nations

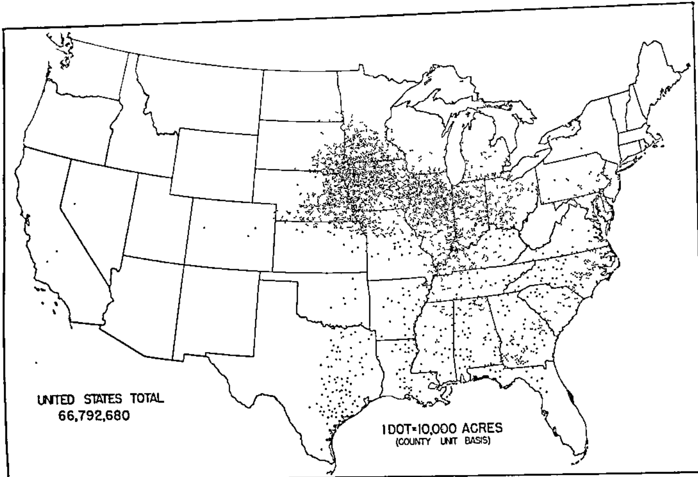

FIG. 69. Corn acreage harvested for grain in 1954. Corn is easily the most important cattle-finishing feed in the United States, but especially is this true in the eastern half of the country. (U. S. Department of Commerce.)

have more and better grass lands; but no other country has such a great supply of corn available for cattle feeding.

Corn is unsurpassed as a feed for finishing cattle. It is highly palatable, being eaten readily by cattle of all ages. It meets the requirements for a high energy feed, being high in digestible carbohydrates and fat—the two nutrients which normally furnish most of the energy in finishing rations. Corn is easily stored and easily prepared for consumption. It is produced in great abundance and, consequently, is relatively cheap. In fact, corn may be said to combine all the essentials of a valuable cattle feed, save one. It is noticeably deficient in protein. For this reason corn should not be fed alone but should be supplemented with feeds that are high in protein, such as the oilseed meals and alfalfa.

In all sections where corn is extensively grown it should, and normally does, form the major portion of the concentrate of the finishing ration. It is seldom possible for Corn Belt feeders to use other carbonaceous concentrates to any great extent without materially increasing the cost of the ration or lowering its efficiency, or possibly doing both. Grain sorghums approach corn in this respect in the southern and western fringes of the Corn Belt.

New vs. Old Corn. In view of the large amount of corn placed in storage under the government loan and purchase agreement, some of which is carried over for 2 or more years, the question arises concerning the feeding value of such corn in comparison with corn that has been recently harvested. Obviously, old corn contains less moisture than new corn and, consequently, is a more concentrated feed. On the other hand, its low moisture content makes it less palatable, both because it is harder to chew and because it probably has lost much of the flavor and aroma possessed by new corn. Carotene assays of corn of different ages show a serious loss of this important nutrient with increase in storage time. This point is probably of little significance if plenty of high-quality legume hay is fed with the corn, but it might be of great importance if the corn is the principal source of carotene. Feeding tests, such as those summarized in Table 114, comparing corn stored for one or more years with that which has been recently cribbed show no significant difference between old and new corn for finishing cattle.

The few feeding tests made with new corn fed before it is dry enough to crib indicate that its greater palatability and probable more efficient conversion largely offset its higher moisture content and lower energy value. In a test made at the Illinois station with yearling steers that had been full fed in the dry lot since April 27, the

test, and steers that were fed new oats from July 24 until August 21, decreasing amounts of oats and increasing amounts of chopped new ear corn from August 21 until October 2, and new shelled corn from October 2 until November 11, when the cattle were marketed. The moisture content of the corn kernels was 59 per cent when the feeding of new corn was begun on August 21, and 24 per cent on October 2 when the change from sliced ears to shelled corn was made. In this second test the steers fed old corn sold for 50 cents per hundred more than those fed new corn and returned, as a result of the higher selling price, approximately $5 per head more profit, despite the fact that new and old corn were valued at 56 and 65 cents a bushel, respectively.

The advent of the field-sheller or corn combine will undoubtedly be responsible for a great increase in the feeding of high-moisture new corn, especially if storage facilities such as the airtight "Harvestore" are available. Such high-moisture grain undergoes fermentation if stored in large quantities and has all the characteristics of silage. For this reason it will be discussed more thoroughly under the topic of ear-corn silage.

Value of Soft Corn. Often a field of late-planted corn fails to mature before the first killing frost, and about once in 8 or 10 years, an unusually early frost damages a considerable percentage of the crop over a large portion of the Corn Belt. Frost destroys the life in the green, growing stalk and halts the translocation of the food nutrients from the stalk to the ear and the transfer of water from the ear to the stalk, where it normally would evaporate through the leaves. As a consequence the ears fail to dry out and they contain an abnormally high percentage of moisture; as much as 40 per cent moisture is not uncommon. Such corn is commonly termed "soft." In practice, soft corn is corn that contains too high a percentage of moisture to be stored in the ear without danger of heating. Heating is likely to occur when the amount of moisture in newly harvested corn exceeds 25 per cent.

Soft corn is also immature and is not to be confused with mature corn that contains a high moisture content. Because soft corn is unmarketable, it is retained on the farm and fed. The feeding value of such corn has long been a matter of controversy. No one will deny that it is inferior to sound corn. However, results obtained at experiment stations where the two feeds have been compared indicate that soft corn is a better feed for finishing cattle than has commonly been supposed. On the basis of dry-matter content, soft corn is as efficient as mature corn in producing gains. However, the gains from

Table 114

THE RELATIVE VALUE OF OLD AND NEW CORN FOR FINISHING CATTLE

	Iowa AH Leaflet 160 (210 days)					Illinois Mimeo. Report, April 26, 1940 (162 days)	
	4-year-old Corn (1937)	3-year-old Corn (1938)	2-year-old Corn (1939)	1-year-old Corn (1940)	New Corn (1941)	2-year-old Corn (1937)	New Corn (1939)
Relative hardness of kernels	164	160	174	150	100	132	100
Moisture (percentage)	10.4	10.0	12.4	12.9	16.7	11.0	16.2
Vitamin A, units per pound of corn	821	809	869	1330	1720	.....	.....
Crude protein (14% moisture basis) (percentage)	9.8	8.5	8.6	8.3	8.0	.....	.....
Average initial weight, pounds	735	736	732	732	738	805	802
Average daily gain, pounds	2.20	2.15	2.10	1.97	2.15	2.49	2.53
Average daily ration, pounds							
Shelled corn (14% moisture)	16.3	15.0	16.1	15.7	14.9	13.7	13.9
Protein supplement	1.0	1.0	1.0	1.0	1.0	1.4	1.0
Alfalfa hay	4.0	4.0	4.0	4.0	4.0	2.1	2.1
Corn silage	.	. . .	.....	.....	.....	18.9	18.9
Feed per cwt. gain, pounds							
Shelled corn (14% moisture)	741	696	766	799	693	552	550
Protein supplement	45	47	48	51	47	55	58
Alfalfa hay	181	187	190	203	186	86	81
Corn silage				.....	.....	762	745
Selling price per cwt.	$14.10	$13.75	$13.60	$13.70	$13.70	$10.25	$10.40
Shrinkage (percentage)	2.0	1.4	3.2	2.3	1.9	2.5	1.3
Dressing percentage	63.7	63.8	63.9	63.5	62.8	61.3	61.8

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Table 115

THE VALUE OF SOFT CORN FOR FINISHING CATTLE*

Two-Year-Old Steers, Fed 80 Days	Soft Corn		Mature Corn from Previous Year
Form of Corn Fed	Broken Ears	Ear-Corn Silage	Broken Ears
Average per cent moisture	35 82	59.65	13.61
Average daily gain, lb.	3.20	3.35	3.52
Average daily ration, lb.			
Ear corn	31.48	...	25.59
Linseed meal	1.89	1.89	1.89
Ear-corn silage	...	45 43	...
Alfalfa hay	2.70	2.35	2.70
Feed per lb. gain, lb.			
Ear corn	9 84	..	7.27
Linseed meal	0.59	0.56	0 54
Ear-corn silage	...	13.56	...
Alfalfa hay	0.84	0.70	0.77
Corn (dry matter) per lb. gain, lb.	6.42	5 34	6.28
Selling price per cwt. ($)	9.35	10.00	9.85
Dressing percentage	60 0	60.7	60.6
Cattle and hog gains per acre, lb.	247.0	292 0	...

* Illinois Bulletin 313.

soft corn are somewhat less rapid because its greater bulk results in a smaller consumption of dry matter in comparison with mature corn.

Corn containing an abnormal amount of moisture becomes so hard from freezing during severe weather that cattle can scarcely eat it. For this reason soft corn should, if possible, be fed during the fall and early winter. In order to obtain as great a consumption of corn as possible, the roughage allowance should be limited to 4 or 5 pounds daily per 1,000 pounds live weight. Silage is not as satisfactory a roughage as hay for cattle fed on soft corn.

Soft Ear-Corn Silage. One of the problems connected with the utilization of soft corn is the matter of storage. Ordinarily the corn is left in the field to be gathered as it is needed. This method is likely to prove inconvenient during bad weather when the field is soft and muddy or is covered with deep snow. This difficulty can be avoided by snapping the ears soon after the first killing frost and making them into ear-corn silage. Such ear-corn silage is superior to the same corn fed as broken ears, as shown in Table 115.

High-Moisture Ear-Corn Silage. Results such as those summarized in Table 116, secured from feeding soft corn in the form of ear-corn silage, have compared so favorably with those ordinarily obtained from feeding sound, mature corn that it may be asked why this method of harvesting and feeding corn need be limited to those occasional years when corn fails to mature.

If high-moisture ear-corn silage produces the same amount of gain in cattle as fully matured ear or shelled corn from an equal area of land, there would seem to be several advantages to be gained by harvesting the corn as ear-corn silage. In the first place it permits the harvesting of a considerable portion of the corn crop during favorable autumn weather. Second, it stores the corn in a form suitable for feeding to cattle of all ages without further preparation, thereby eliminating the expense and extra handling of feed involved in grinding or shelling. Third, it makes possible the pasturing of stalk fields while they are still green and palatable, or the making of the green stover into green stover silage. Or, if the green stover is not needed, the stalks may be plowed under early enough for the field to be sown to wheat.

The method for making ear-corn silage is relatively simple The ears, with or without the attached husks, are gathered with a mechanical picker without husking rolls, and hauled to the silo to be ground

Table 116

EAR-CORN SILAGE FOR FINISHING CALVES*

Equal Areas of Corn Harvested and Fed	Ear Corn Silage	Ear-Corn Silage	Mature Corn (C. and Cob meal)
Date harvested	Sept. 4-9	Sept. 24-25	Oct 25-30
Moisture in grain when harvested	*53 4%*	*37 5%*	*Under 25%*
Average daily gain	2 23 lbs.	2 12 lbs.	2 10 lbs.
Average daily ration:			
Corn component	29 4	27 3	13 3
Cottonseed meal	1 6	1 6	1 6
Alfalfa hay	2 0	2 0	2 0
Oat straw			2 9
Total days feed from area	*3,018 days*	*3,153 days*	3,329 days
Calc. total gain to be credited area	6,721 lbs.	6,686 lbs	6,987 lbs.
Selling price per cwt.	$15 70	$15 65	$15 35
Dressing percentage	61 1	61 4	60 4
Return per bushel of corn obtained from the area allowed to mature	$1 19	$1 11	$1 07

* Illinois Experiment Station, Mimeographed Report, 1928-29, Calf Feeding Experiments.

· chopped and blown into the silo. It is not necessary to tramp the lage in the silo because the weight of the corn and the absence of uch bulky material causes the silage to settle almost as rapidly s it is made. However, it is necessary to have someone in the silo o see that the silage is evenly distributed. Otherwise the cut corn ends to pile up in the center whereas the husks and cobs accumulate long the walls.

If the corn is overly ripe and contains insufficient moisture to nsure thorough packing and fermentation, a small amount of water should be added by introducing a pipe or hose into the blower of the cutter. When the job is finished the silo should be sealed either by running sufficient green stover or other forage through the cutter to make a layer approximately 3 feet deep on top of the ear corn, or by covering it with one of the newly developed plastic silo caps. When ear-corn silage is so sealed, little spoilage occurs. Again, the air-tight or oxygen-free silo is ideal for storing such silage if cost is not to be considered.

Since ear-corn silage is heavy in proportion to its volume, a relatively small silo holds sufficient silage to feed a carload of cattle, even though they receive little other feed. If the silo is of the conventional type and is too large in diameter, a small drove of cattle will require insufficient silage daily to prevent spoilage in warm weather. A silo 12 by 40 feet holds approximately 120 tons of ear-corn silage, or enough to finish 40 to 50 head of cattle during the usual length feeding period.

More recent work by the Iowa and Indiana stations is reported in Table 117. These studies deal with corn which definitely must be considered mature since it contained only 32 per cent moisture or less. These studies indicate, as did the Illinois studies with immature ear-corn silage, that the dry matter of high-moisture ear-corn is superior to that of mature dry corn when stored as ear-corn silage, since faster gains are produced on less dry matter. A probable explanation is that the cob portion of the ear-corn silage is more efficiently utilized by the rumen microorganisms as a result of the fermentation it undergoes in the silo. On a dry basis, ear-corn silage consists of approximately 20 per cent cob. It should be noted in Table 117 that dry matter intake was not increased in the high-moisture corn lots. Consequently it cannot be said that the corn is more palatable, although it would seem so upon observing the apparent relish with which such corn is consumed by cattle.

Experimental data on the feeding value of ensilaged high-moisture shelled corn is needed but is not available at the present time. It

Table 117

VALUE OF MATURE HIGH-MOISTURE EAR-CORN SILAGE COMPARED WITH DRY GROUND EAR-CORN FOR FINISHING CATTLE*

Experiment Station	Indiana				Iowa		
Year	1956		1957		1957		
Days on Test	117		126		119		
Moisture and additives	*High moisture* 32.2%	*Dry ground* 17.7%	*High moisture* 32.5%	*Dry ground* 15.5%	*High moisture* 31%	*Dry ground* 14.5%	*High moisture* 31% and Stilbest.
Number of animals	10	16	36	35	36	36	18
Sex	Steers	Steers	Heifers	Heifers	Steers	Steers	Steers
Initial weight, lb.	958	960	467	466	804	802	805
Pounds gain	299	272	279	275	354	364	327
Av. daily gain, lb.	2 56	2 33	2.21	2.18	2.98	3.05	3.17
Ground ear-corn per day, lb †	20.6	22 1	11 88	13.45	20 0	22.9	20.4
Total feed per day, lb †	23 3	25 8	18.43	20 22	24.3	27.2	24.7
Gr ear-corn per cwt. gain, lb †	807.0	951 0	555 0	617.0	675.0	750 0	613 0
Total feed per cwt gain, lb †	953 0	1,111 0	860 0	927.0	819.0	889 0	778 0
Cost per lb gain (¢)	22	25	17.4	18 4	14.8	16.1	14.1
Advantage of high-moisture corn (¢)	3		1	1 3	1.3		2.0

* Indiana Feeders Day Reports, 1956 and 1957, Iowa Feeders Day Report, 1957

† All high-moisture corn values converted to equivalent moisture for comparison

seems logical to assume that this method of storing such corn has merit, provided that air can be absolutely excluded. It is obvious that such corn has more air space around the individual grains than does ground ear-corn. The author has observed a number of farms on which shelled corn silage is being successfully stored in conventional silos. Less spoilage occurs if a large number of cattle is fed and if the corn is fed out before the warm weather of summer arrives.

Effect of Artificially Drying High-Moisture Corn. Extensive data are not available on this presently important question. For those farmers who do not have a silo for storing high-moisture corn but who nevertheless wish to take advantage of the benefits of field shelling, artificial drying seems a practical alternative. A problem presents itself in the heavy corn-growing areas because the capacity of the customary flow-type dryers operated by the elevators is not sufficient to keep up with the large amount of corn which suddenly needs drying when field shelling commences in earnest. Either farm-size or larger portable "batch" dryers which ordinarily rely on forced air, heated to temperatures ranging from 180° F. and upwards, are being used to take care of this emergency. The data shown in Table 118 indicate that drying 30 per cent moisture content mature corn at 180° F. did not reduce its feeding value.

Effect of Variety of Corn upon Feeding Value. During the period 1930–1940, when hybrid corn was rapidly displacing the open-pollinated varieties, the relative feeding value of the different hybrids was widely discussed. Some hybrids were claimed to be so hard that they were eaten with difficulty and consequently the kernels were swallowed with only a little chewing. Other varieties were believed not only to be softer but also to possess an aroma and flavor that made them more palatable. Regardless of the results obtained from such tests, a discussion of this topic is no longer of importance inasmuch as open-pollinated corn has been replaced by hybrid corn for all practical purposes. Plant breeders have been doing, and will continue to do, research in breeding "tailor-made" hybrids for specific purposes For example, special hybrids have been developed which produce more tonnage of forage and therefore are ideally suited for silage. However, such "silage hybrids" have not produced more beef gains per acre, primarily because of the lower yield of grain. Still other special hybrids have been produced which are 50 per cent higher in protein content than ordinary corn. Feeding trials such as the one reported in Table 119 indicate that protein supplements may be eliminated from finishing rations in the future, if plant breeders improve the yields of the high-protein corn hybrids. Hybrids have also

Table 118

RESULTS OF HIGH-TEMPERATURE DRYING OF HIGH-MOISTURE FIELD-SHELLED CORN WHEN FED TO BEEF STEERS*

(November 17, 1954–March 23, 1955, 126 Days)

Type of Corn Fed	Lot 6 Field-dried 16%-Moisture Corn	Lot 7 High-Temperature Dried† High-Moisture Corn
Number of calves	9	10
Average initial weight, lb.	556	554
Average final weight, lb.	858	859
Average daily gain, lb.	2.39	2.42
Average daily ration, lb.		
Corn silage	16 8	17.3
Shelled corn	9.1	9.1
Alfalfa hay	2.1	2.1
Soybean oil meal	1.3	1.3
Feed cost per cwt. gain ($)‡	16 88	16.81

* Illinois Cattle Feeders Day Report, 1955.

† Corn contained 30% moisture and was kiln-dried at 180° F until it contained 16% moisture

‡ Feed prices used were: corn silage, $12 per ton; shelled corn, $1.40 per bu.; soybean oil meal, $80 per ton; alfalfa hay, $20 per ton.

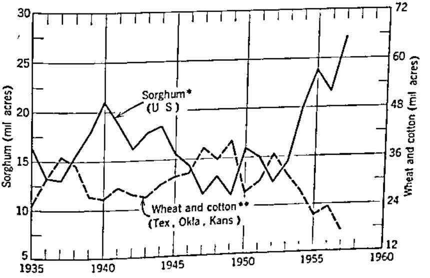
been developed which contain twice the usual amount of fat, and work is in progress to develop hybrids whose stalks contain high levels of sucrose or sugar.

Feeding Corn to Breeding Animals. Although corn ranks high as a feed for finishing cattle for market, its use as a feed for breeding animals is often severely criticized. It is stated that, owing to its high starch and fat content, corn is likely to produce such an accumulation of fat around the reproductive organs that their normal function is impaired. Also it is thought that the great strain put upon the digestive system by the digestion and assimilation of such a highly concentrated feed, and upon the excretory system by the elimination of the oxidized products, may result in a serious and perhaps permanent derangement of some of the organs of these systems. This latter condition, commonly referred to as "burnt up by too much corn," is regarded as particularly likely to occur in young bulls and heifers No one will deny that breeding animals should not be kept in too high condition It is not an established fact, however, that it is necessary to withhold corn from breeding animals to avoid these effects. Rather,

of drought in many parts of the country, which reduced yields of other crops, especially corn and wheat, to the extent that the more drought-resistant grain sorghums have replaced many acres of the drought-subject crops, even in the Corn Belt.

The twofold increase in acreage of grain sorghums within the last 10 years is shown in Figure 70. It should be noted that the increase in bushels produced is even greater than the increase in acreage. A twofold increase in yield per acre resulted primarily from the development of better hybrids and the shift of some of the acreage to the more productive Corn Belt soils and irrigated valleys of the West. The figure also shows that cotton and wheat acreages have been reduced in the principal grain-sorghum growing states to about the same extent as grain sorghum acreages have increased.

Sorghums are still being grown extensively throughout the southern half of the country, as seen in Figure 71. It should be mentioned that, whereas sorghums were predominantly a southwestern crop 5 years ago, sorghums have moved into the remainder of the country since Figure 71 was prepared. The newer hybrids are not only higher yielding with respect to grain but they have also been adapted to harvesting with the combine by reducing stalk height. A problem that is still occupying the attention of plant breeders is that of late



* Acreage planted to all sorghums
** Acreage of wheat harvested and cotton in cultivation July 1

FIG. 70. Sorghum and wheat-cotton acreage Acreage of sorghums in Texas, Kansas, and Oklahoma—which usually accounts for three-fourths of the U S total—varies inversely with wheat and cotton acreage in those states (U S D A)

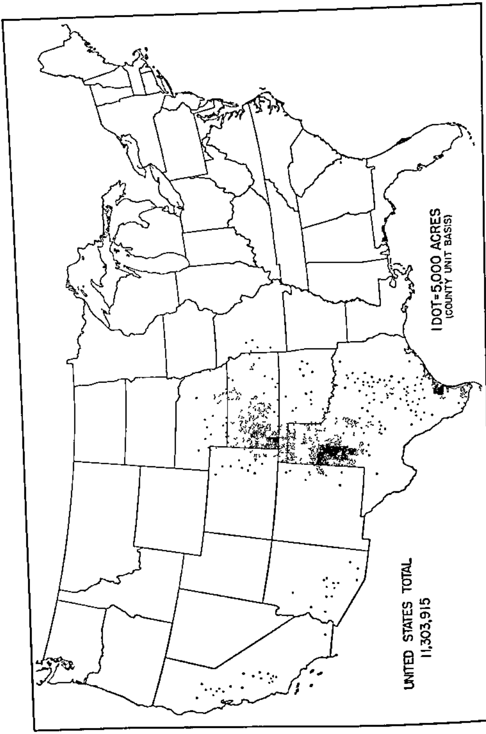


FIG. 71. Sorghums harvested for grain or for seed in 1954. (U. S. Department of Commerce.)

maturity. Each year thousands of acres are damaged by frost before maturity is reached. The development of open or "sprangly-headed" hybrids has helped in reducing the moisture in the grain so as to insure safe storage after combining, but high moisture is still a serious problem.

A discussion of recommended varieties and hybrids would have little point here because so much variation exists among areas throughout the country with respect to rainfall, length of growing season, soil fertility, and drying conditions. Local or state crop specialists should be consulted for recommendations as to suitable varieties and hybrids, and because improvements are being made each year, changes in local recommendations should be followed. Yields of 100 bushels or more per acre are not rare in modern grain sorghums, and yields of newer combine-type hybrids consistently compare favorably with corn.

In chemical composition, grain sorghums in general are quite similar to shelled corn. An exception is protein content, which is higher in grain sorghums by 2 percentage points—roughly 11 per cent versus 9 per cent in corn. The two feeds are approximately equal with respect to total digestible nutrients or energy content, and both are low in calcium and phosphorus. The carotene content of grain sor-

FIG. 72. Hybrid grain sorghums are increasing in importance as a source of high-energy concentrate for finishing rations (University of Illinois)

ghum is very low. Fortification of sorghum rations with carotene or vitamin A concentrate is absolutely essential in finishing rations which do not also contain at least 4 to 6 pounds of excellent quality legume hay or an appreciable amount of good silage. High-carotene content hybrids appear promising in the developmental stages and may eventually offset the lack of this nutrient in grain sorghums.

Sorghums should always be ground or rolled for feeding to cattle because they are hard-seeded and much of the sorghum grain otherwise passes through the digestive tract in a rather incomplete stage of digestion. More will be said about effect of preparation on the feeding value of sorghums in Chapter 26. Swine do not do a good job of recovering sorghums from voided cattle feces.

Sorghums are usually fed in finishing rations in the form of ground threshed grain, but in some instances ground head chop is fed, which is similar in feeding value to ground ear corn. Although feeding trials with the newer hybrids are few, it appears that the data from older studies with conventional grain-type sorghum varieties are still applicable, because the chemical composition of the old and the new sorghum types is so similar. Table 120 shows the results of some of the older comparisons between standard early-day sorghum varieties and corn. These comparisons indicate that grain sorghums have a feeding value approximately equal to or slightly below that of shelled corn.

Sorghum Head Silage. One solution to the storage problem of high-moisture content sorghum grain is to harvest the crop with a field ensilage chopper, taking only the head portion of the stalk and storing it in a silo. Experimental data for comparison of sorghum-head silage and ear-corn silage are not available. However, Table 121 shows the results of a comparison between cracked shelled corn and whole sorghum grain, ensiled while it still contained 40 per cent moisture.

Oats. Formerly oats were not of great importance in beef cattle feeding, but with the loss of the market for oats for feeding horses, they are now used rather extensively for cattle in many parts of the country. For finishing purposes oats are too high in crude fiber and too low in digestible nutrients to be fed alone, but when mixed with other grains such as corn or sorghum, which are higher in energy and less bulky, they give very satisfactory results. The tough, fibrous hull and the small size of the kernel make it advisable to grind oats for older cattle since they swallow a considerable percentage of the kernels without sufficient chewing if the oats are fed whole. Grinding oats, as a rule, is not advisable for calves unless the grain with which

Table 120

Comparative Value of Grain Sorghums for Finishing Cattle

	Daily Ration			Average Daily Gain	Feed per Cwt. Gain		
	Grain	Protein Concentrate	Roughages (Dry Basis)		Grain	Protein Concentrate	Roughage (Dry Basis)
I* Cracked shelled corn	17.1	1.1	6.0	2.86	598	37	211
Cracked white kafir	16.5	1.1	5.9	2.49	662	42	236
II* Cracked shelled corn	10.6	1.5	3.2	1.94	546	77	167
Cracked Atlas sorghum	12.0	1.5	3.6	2.08	575	72	172
III* Cracked shelled corn	11.1	1.5	3.4	2.01	553	74	170
Cracked Sooner milo	11.7	1.5	3.4	2.03	573	74	169
IV* Cracked shelled corn	11.2	1.5	3.7	2.07	541	73	180
Cracked early kalo	12.1	1.5	3.8	2.04	594	74	187
V† Ground shelled corn	7.4	2.5	4.1	2.05	370	110	200
Ground darso	7.8	2.6	4.1	1.80	437	145	228
VI‡ Ground shelled corn	14.6	1.9	4.8	2.10	695	89	227
Ground Wheatland milo	17.0	1.9	4.8	2.41	706	78	199
Ground Blackhull kafir	16.3	1.9	4.7	2.29	711	82	207
Ground Westland milo	16.8	1.9	4.8	2.19	770	86	219

* *Nebraska Bulletin* 347

† Oklahoma Bulletin 237.

‡ Kansas Mimeo. Report 42-B-2.

Table 121

HIGH-MOISTURE WHOLE SORGHUM GRAIN FOR FINISHING MEDIUM GRADE STEERS*

Lot Number	I	II
Ration	Cracked Shelled Corn	Sorghum Grain from Silo (40% Moisture)
Number of animals	10	19
Av initial weight, lb.	810	814
Av final weight, lb.	1,055	1,021
Av daily gain, lb.	3.14	2.66
Feed consumed daily, lb.		
Cracked shelled corn, 14% M.	17.1	...
Sorghum grain, 14% M.†	...	16.8
Supplement	1.5	1.5
Alfalfa hay	6.0	6.0
Minerals and salt	0.1	0.1
Total	24.7	24.4
Feed per cwt. gain, lb.		
Grain	548	634
Supplement	48	57
Alfalfa hay	191	226
Minerals and salt	4	3
Total	791	920
Feed cost‡ per pound gain, ¢	15.9	13.9
Selling price of steers, $	21.40	19.70

* Iowa Cattle Feeders Report, 1958
† Converted to 14% moisture basis.
‡ Cracked shelled corn priced at $1.25 and grain sorghum at $0.75 per bushel.

the oats are fed is also ground, in which case grinding insures a better mixture of the two feeds.

Both whole and ground oats are more palatable than corn for calves, as indicated by the relative amounts eaten in the Kansas experiment reported in Table 122, where the two grains were fed free-choice in separate self-feeders. The slight difference in palatability was probably due to the fact that the oat grains were softer and more easily chewed than the kernels of corn.

Feeding experiments indicate that oats more nearly approach the value of shelled corn for feeding heavier cattle than for feeding calves. In tests conducted at the Indiana station with 2-year-old steers the substitution of ground oats for one-third of the shelled corn ration slightly decreased the feed required per 100 pounds of gain. However, in none of the 7 experiments with calves shown in Table 123 did oats

have as high feeding value as shelled corn. On the average 118 pounds of oats replaced 100 pounds of shelled corn, or 2 bushels of oats replaced approximately 1 bushel of shelled corn. One objection to feeding oats to young feeder cattle is that oats tend to make the cattle grow rather than fatten. This fact is substantiated by the lower prices received for most of the oat-fed lots when they were marketed. Oats are approximately equal to ground ear corn when fed so as not to exceed half of the concentrate portion of the ration.

Oats may constitute as much as one-half or two-thirds of the grain ration while the cattle are becoming accustomed to a full feed Since oats contain less energy and are more bulky than corn, their use at this time lessens the danger that some of the steers will overeat and become foundered. However, the oats should gradually be reduced in amount as the feeding progresses, so that they form only 20 to 30 per cent of the grain ration, or possibly be eliminated altogether, during the last third of the finishing period. Obviously the relative prices of corn and oats should be considered carefully in determining the extent to which oats should be used in the finishing of cattle for market. As stated above, the feeding of large amounts is not profitable unless the price of oats per bushel is less than one-half that of corn. Swine which follow cattle in the feed lot appear to make almost no use of the oats which the cattle fail to digest. Conse-

Table 122

RELATIVE PALATABILITY OF SHELLED CORN AND OATS WHEN FED FREE-CHOICE TO BEEF CALVES*

	Lot 1		Lot 2	
	Shelled Corn	Whole Oats	Ground Shelled Corn	Ground Oats
Average daily consumption, lb.				
1st 28 days	1.96	3.18	1.83	3.45
2nd 28 days	1.96	5.85	2 50	5 02
3rd 28 days	4.56	4.57	4 96	4 35
4th 28 days	4 70	6 32	6 48	5 46
Last 26 days	2.44	8.53	4.80	7.33
Average 138 days	3.14	5.65	4.10	5.09
Average initial weight, lb.	412		409	
Average final weight	738		729	
Average daily gain	2 36		2 32	

* Kansas Cattle Circular 38B

Table 123

Comparison of Corn with Corn and Oats for Finishing Cattle

	Shelled Corn			Shelled Corn and Oats			
	Daily Gain	Grain per cwt. Gain	Selling Price per cwt.	Ratio of Corn to Oats	Daily Gain	Grain per cwt. Gain	Selling Price per cwt.
	lbs.	lbs.			lbs.	lbs.	
Two-year-old steers .							
Indiana Bulletin 371.	2 50	593	$12.90	2:1[a]	2.60	564	$13.00
Indiana Bulletin 371.	1.88	584	11.50	2:1[a]	2.16	508	11.75
Indiana Bulletin 371.	2.15	592	7.45	2:1[a]	2.18	586	7.50
Calves							
Illinois, 1912–13.	2.00	594	8.50	4:1	1.96	603	8.55
Illinois, 1935–36. . . .	2.06	447	8.65	2.5:1	2.02	472	8.65
Nebraska, 1922–23 . . .	2 47	453	9 50	2:1	2.40	494	9.25
Minnesota Bull. 237. . .	2 32	580	9 60	4:1	2.19	602	9.40
Oklahoma, 1937–38. .	1 95	469	8.75	1[a]:1[a]	1.95	495	9.00
Kansas, 1932–33	2.11	444	6.75	0:1[b]	2.02	442	6.00
Kansas, 1933–34.	2 14	476	7.00	1.3:1	2.13	516	6.75
Average of 7 lots of calves	2 15	495	$8.40	....	2.09	518	$8.25

[a] This grain fed ground

[b] Whole oats alone fed first 100 days and shelled corn alone last 100 days.

quently the substitution of oats for a considerable part of the corn ration results in much smaller hog credits.

Oats are somewhat higher in protein and mineral content than corn and for this reason they are especially valuable for breeding stock. When used in mixtures with other grains they are highly regarded by herdsmen who fit cattle for shows and sales. For such animals the oat hulls are in no way objectionable since they give bulk and lightness to the grain ration.

Barley. Large amounts of barley are used in cattle feeding in the northern and northwestern states and in Canada. At these latitudes corn often fails to mature and barley, with its shorter growing season, is raised to take its place Barley is also grown to a limited extent along the western edge of the Corn Belt, where a grain crop is desired which will mature before the arrival of hot, dry weather.

Barley, like oats, has a kernel surrounded by a tough, heavy hull which materially lessens its digestibility and renders it somewhat

unpalatable unless it is ground. The kernel itself is rather hard and flinty in texture and does not "chew up" as easily as corn. This fact makes the grinding or crushing of barley all the more necessary if satisfactory results are to be obtained from its use. The feeding of whole barley is a wasteful practice since a high percentage of the kernels are not chewed sufficiently well to permit them to be thoroughly digested. Undigested kernels of barley, like those of oats, are not utilized readily by the swine which are kept in the feed lot.

In chemical composition, barley falls midway between oats and corn. Because of its higher protein and mineral content it is a somewhat better balanced feed than corn, but its lower percentage of fat and greater amount of fiber make it less fattening. Many comparisons have been made between shelled or ground corn and ground barley as feeds for finishing cattle. Some of the results of these studies are shown in Table 124.

Barley may vary considerably in quality. This factor may be highly important, as is shown by the daily gains of 3 lots of steers fed shelled corn, native barley, and northern-grown barley by the Illinois station. The gains were 3.08, 2.81, and 3.35 pounds a head, respectively. Since weather conditions for the production of a high grade of barley are almost the opposite of those required for a good grade of corn, it is not surprising that there is much variation in the results obtained in studies of the relative value of these two grains.

Although feeding tests show considerable variation in the relative value of corn and barley for finishing cattle, most of them indicate

Table 124

BARLEY VS. CORN FOR FINISHING CATTLE

	Steer Calves*		Yearling Steers† (4 Years)		*Steer Calves‡*	
	Ground Shelled Corn	Ground Barley	Ground Shelled Corn	Ground Barley	Shelled Corn	Ground Barley
Daily gain, lb.	2.11	1.96	2.02	2.00	2.34	2.21
Feed per cwt. gain, lb.						
Grain	570	613	379	384	470	478
Protein concentrate	47	51			64	68
Corn silage					414	431
Hay	176	199	841	821	119	114
Selling price per cwt., $	7.75	7.60	20.40	19.40	11.25	11.00

* Kansas Cattle Circular 36A
† Oregon Bulletin 528
‡ Minnesota Bulletin 300

that ground barley is less palatable than shelled corn, that it has a tendency to cause bloat, and that barley-fed cattle usually sell for less than corn-fed cattle when marketed. In view of these facts the feeding of barley alone is confined largely to those sections of the country where barley is extensively grown and consequently is relatively cheap.

In the Corn Belt proper, barley should always be fed mixed with corn or corn and oats to lessen the frequency of bloat. In such mixtures barley has a feeding value fully equal to that of corn, but when fed alone its value is only about 90 per cent that of corn on a pound basis. Or we may say that 5 bushels of barley have about the same feeding value for finishing cattle as 4 bushels of shelled corn.

Barley for Breeding Animals. Barley stands high in the estimation of feeders of breeding animals. Also, in the fitting of animals for the show ring it is regarded with much favor. The barley-fed steers of the Northwest and the Pacific Coast have long been noted at the International Live Stock Exposition for their wonderful handling qualities and "touch." Several grand champion steers have been developed in these regions with the use of scarcely any corn, barley being the principal concentrate fed. Nearly all experienced feeders agree that there is nothing superior to barley to "mellow up" an animal that has become a bit hard in his flesh or to prevent a highly finished beast from becoming rough and patchy. A possible explanation for this reported phenomenon, which evades scientific explanation, is that the feeding of barley results in a somewhat slower rate of gain

Wheat. Wheat is fed to beef cattle only when its price is abnormally low so that its cost per pound is comparable with that of corn. Owing to the small size of the kernels, wheat must be ground to insure its thorough digestion. Wheat should not be fed alone since the protein (gluten) becomes sticky when mixed with saliva and is not greatly relished by the cattle. However, this objection is easily overcome by mixing ground wheat with other grains such as shelled corn or ground oats. Such a mixture is sufficiently more valuable than corn alone to justify the feeding of wheat when corn and wheat are the same price per pound, even though the cost of grinding is 4 or 5 cents a bushel.

Results secured at the Kentucky[1] and Kansas[2] Experiment Stations indicate that ground wheat may successfully be fed alone if it is spread evenly over a rather liberal feed of corn silage. Evidently the

[1] Kentucky Bulletin 332.
[2] Kansas Bulletin 261.

silage reduces the sticky nature of the ground wheat by supplying more bulk and by compelling the cattle to eat the wheat more slowly.

Table 125 gives comparative values of oats, barley, and sorghum grain in terms of various values placed on corn. Adjustments for differences in feeding value and for different weights per bushel were taken into account.

Rye. Rye is usually regarded as a feed for swine and as a rule is fed to beef cattle only when its price per bushel is considerably below that of corn. Rye grains are small and hard and, of course, should be ground. Like wheat, rye gives much better results when fed with corn than when fed alone. When so fed, ground rye may be considered equal to ground wheat. (See Table 126)

Grain Mixtures. Experienced feeders of purebred cattle greatly prefer a mixture of several grains to corn alone for fitting cattle for the show and sale ring. On the other hand, the men who feed steers for the market usually feed only corn or sorghum alone unless these grains are scarce and high in price compared with other grains. Feeding experiments indicate that grain mixtures usually are sufficiently better than single grains such as corn or barley to justify their use, even though additional labor is required in their preparation. An exception to this statement appears to be a mixture of corn and oats for calves, which, as shown in Table 123, usually produces smaller gains and less finish than corn alone. Another exception is a mixture of ground oats and barley, which probably contains too much fiber and is too bulky for young animals.

Table 125

APPROXIMATE VALUE OF OATS, BARLEY, AND SORGHUM GRAIN IN TERMS OF PRICE LEVELS FOR CORN WHEN FED TO BEEF CATTLE*

If Corn Price per Bushel Is:	Value of Other Grains When Fed		
	Oats per Bushel	Barley per Bushel	Sorghum Grain per 100 Pounds
$1.00	$0.48	$0 76	$1.65
1.10	0 53	0 83	1 81
1.20	0.58	0 91	1.98
1.30	0 63	0 98	2.14
1 40	0 68	1.06	2 31
1.50	0.73	1.14	2.47
1.60	0.78	1.21	2 64
1 70	0 83	1.28	2 79

* Courtesy Malcolm Clough and Ralph Jennings, U S.D A , 1956

Table 126

Comparison of Single Grains with Grain Mixtures for Finishing Cattle

	Corn and Ground Oats			Corn and Ground Barley			Corn, Ground Wheat, and Ground Oats				Ground Oats and Ground Barley			Corn and Ground Wheat, and Corn and Ground Rye	
	Indiana Bull. 371 (2-Year-Old Steers)			Illinois Report, 1928 (2-Year-Old Steers)			Illinois Report, 1930 (2-Year-Old Steers)				Minnesota Bull. 300 (Calves)			Nebraska Bull. 295 (Calves: 3 Years, Average)	
	Corn	Oats	Corn 2 and Oats 1	Corn	Barley	Corn 1 and Barley 1	Corn	Corn 1 and Wheat 1	Oats 1 and Wheat 1	Corn 1 Oats 1 Wheat 1	Oats	Barley	Barley 2 Oats 1	Shelled Corn 1 and Ground Wheat 1	Shelled Corn 1 and Ground Rye 1
Av. daily gain, lb.	2.18	2.19	2.31	3.08	2.81	3.16	2 32	2 12	2 36	2.58	2 09	2.24	2.15	2.28	2 28
Av. daily ration															
Grain	12.8	12.1	12.7	15.6	16.0	15.6	15 8	15 8	15.0	15.7	10.2	10.7	10.5	10.7	10.8
Prot. conc.......	2.6	2.6	2.6	2.2	2 3	2.2	2.2	2.2	2.1	2.2	1.5	1 5	1.5	....	....
Silage..........	29.3	29.2	28.9	19.2	19.6	19.3	....	....	....	....	7.2	7.9	7.1	....	....
Hay...........	3.1	2.5	3.1	2.0	2.0	2.0	5.2	5.2	5.2	5.2	2.1	2.5	2.1	5.9	5.6
Feed per cwt. gain															
Grain..........	590	555	551	507	571	495	680	653	634	609	489	478	487	473	474
Prot. conc.......	120	118	113	72	82	71	95	91	88	85	69	65	67	....	....
Silage..........	1350	1336	1260	622	699	611	....	....	....	....	344	354	328	....	....
Hay...........	158	111	131	65	71	63	223	213	219	200	102	111	98	261	246
Selling price per cwt.	$10.62	$10.10	$10.75	$13.75	$13.75	$11.00	$9.15	$9.70	$9.70	$9.70	$12.75	$13.75	$13.50	$6.92	$6.87
Pork credits, lb.....	86	66	72	32	8	17	31	34	0	14	....	....	....	....	....

Hominy Feed. Most of the by-products of the milling industry which are fed to beef cattle are relatively high in protein content and are classed as nitrogenous rather than carbonaceous concentrates. An important exception is hominy feed, which is a by-product of the dry-process method of milling corn. Hominy feed consists of the corn germ, the outer coating or bran, the tips of the kernels, and small particles of starch from the endosperm, which result from the removal of these parts from the whole kernel Hominy feed is somewhat higher in protein and mineral content than whole corn, partly owing to the presence of the corn bran but principally to the fact that the percentage of moisture is considerably lower because of the kiln-drying of the corn before milling.

Hominy feed has proved to be a satisfactory substitute for shelled corn in the few experiments in which it has been fed. However, it is too bulky to be fed alone successfully but may constitute up to 50 per cent of the grain ration when mixed with non-bulky feeds such as corn and sorghum

Beet Pulp. In the manufacture of sugar from beets, great quantities of wet beet pulp result as a residue of the sugar-extraction process Thousands of cattle and tens of thousands of sheep and lambs are finished annually on this material in the beet-growing sections of the West. Because of the large amount of moisture that it contains—approximately 90 per cent—wet beet pulp should be regarded as a diluted carbonaceous roughage similar to corn silage. Consequently it will be discussed in connection with that subject in Chapter 21.

A considerable quantity of the beet pulp produced at the sugar refineries is dried with waste steam to produce "dried beet pulp." This dried pulp may be bagged and sold as plain *beet pulp,* or it may be mixed with molasses to produce *dried molasses beet pulp* Approximately 100 pounds of the plain dry pulp are obtained from each ton of sugar beets processed Five hundred pounds of molasses are mixed and dried with about 1,600 pounds of dried pulp to make a ton of dried molasses beet pulp.[3]

In chemical composition dried beet pulp is a carbonaceous concentrate. Because of its bulk it produces slightly faster gains when mixed with corn or ground barley than when it is fed alone Mixtures of 1 part of dried beet pulp and 2 parts of corn, or equal parts of dried pulp and shelled corn, were equal in all respects to a full feed of shelled corn in three tests carried out at the Nebraska station. Plain dried pulp gave as good results as dried molasses pulp when fed with

[3] Colorado Bulletin 422.

ground barley in two tests made at the Colorado station. (See Table 127.)

Usually the cost of beet pulp is considerably higher than the price of corn or barley; consequently it is not fed to beef cattle to any extent except in the vicinity of sugar refineries where it is purchased directly from the mills. Frequently small amounts are used in fitting cattle for show. One quart of dried beet pulp moistened with 1 quart of diluted feeding molasses or plain water and allowed to swell overnight yields up to about 2 quarts of soft, succulent feed which may be fed alone or mixed with other concentrates.

Molasses. A large quantity of low-grade molasses is produced each year as a by-product of the sugar-refining industry. Added to our own domestic supply, large quantities are imported, principally from Puerto Rico and Cuba. Frequently it is shipped in tank cars to the locality where it is to be fed and drawn off into wooden or steel barrels holding 500 to 600 pounds each.

Feeding molasses is of three kinds—cane, beet, and corn—depending upon the plant from which it is made. Most of the cane molasses is made in the South, where it is commonly called "blackstrap." Beet molasses is produced principally in the sugar-beet areas of the West. Corn molasses, called "Hydrol," is available in relatively small amounts for feeding purposes. It is a by-product of the corn-milling industry in the manufacture of corn sugar. Formerly cattle feeders showed a strong preference for cane molasses, claiming that the beet variety was less palatable and much more laxative. A more extensive use of beet molasses, however, has convinced feeders that there is little difference between the two kinds. The use of corn molasses in beef-cattle feeding has been too limited to permit a definite statement about its feeding value. However, in three tests in which it was used at the Illinois and Nebraska stations[4] no superiority over "blackstrap" was disclosed. Because of its high viscosity, corn molasses is difficult to handle during cold weather.

Apparently many erroneous opinions are held regarding the value of molasses as a feed for finishing cattle. Occasionally farmers are encountered who consider molasses a possible substitute for cottonseed meal. Nothing could be farther from the truth. Molasses is exceedingly low in protein and its use requires the feeding of more, rather than less, protein concentrate. Because of its sweet taste, pronounced odor, and syrup-like appearance, it is almost universally considered to be highly palatable, yet it has been shown that sprinkling molasses diluted with water on cottonseed hulls or good quality wheat

[4] Illinois Mimeographed Report 1937, and Nebraska Bulletin 355.

Table 127

VALUE OF DRIED BEET PULP FOR FINISHING CATTLE

	Colorado Bull. 422		Colorado Bull. 422		Nebraska Bull. 359		
	Ground Barley	Dried Molasses Beet Pulp	Ground Barley and Plain Beet Pulp	Ground Barley and Dried Molasses Beet Pulp	Ground Shelled Corn	Ground Shelled Corn 2 and Dried Beet Pulp 1	Ground Shelled Corn 1 and Dried Beet Pulp 1
Average initial weight, pound	713	723	348	349	549	550	546
Average final weight	1,120	1,120	746	746	1,064	1,059	1,060
Average daily gain	2.20	2.20	2.04	2.03	2.19	2.17	2.19
Average daily ration							
Grain	10.6	...	3.6	3.6	10.9	7.2	5.4
Dried beet pulp	...	10.7	3.4	3.4	....	3.6	5.4
Protein concentrate	2.1	2.1	1.0	1.0	1.0	1.0	1.0
Silage	15.7	15.6	9.2	9.2	21.2	17.3	16.6
Legume hay	7.3	7.7	4.2	4.2	1.9	1.9	1.9
Selling price per cwt	$10.14	$10.35	$9.86	$9.84	$15.35	$15.35	$15.35
Dressing percentage	63.0	63.8	62.5	62.5	59.0	60.5	60.2

straw does not always increase the consumption of these roughages.[5] It is true that when cattle are first fed molasses they show a pronounced liking for it, but it is also true that when it is self-fed its consumption usually declines steadily, becoming only 2 or 3 pounds per head per day during the last part of the feeding period. Lastly, the claim is made that molasses intensifies thirst, causing the cattle to drink abnormally large amounts of water. Experiments substantiate this claim in so far as it refers to such large quantities of molasses as 5 or more pounds per head per day. However, the effect of only 1 or 2 pounds daily upon the consumption of water is negligible. Moreover, there is no basis for believing that cattle obtain any benefits from drinking unusually large amounts of water.

Feeding experiments indicate that 1 or 2 pounds of molasses usually can be supplied to full-fed cattle without appreciably affecting the consumption of the other feeds. In theory this intake of additional nutrients should result in an increase in the rate of gain, but in only a few of the experiments in which small amounts of molasses have been fed has the increase been significant. In fact, in 10 out of 25 experiments in which not more than 5 pounds of molasses were fed daily the average gains were no larger than those of the check lots. Since molasses increased the cost of the ration and on the average lessened instead of increased the selling price, the use of small quantities for the purpose of accelerating gains and producing a quick finish is hard to justify. (See Table 128.)

Molasses has a definitely useful place in cattle feeding during times of grain scarcity. By feeding molasses in amounts large enough to replace from one-third to two-thirds of the usual grain ration a sufficient number of cattle may be finished to utilize the farm roughage supply to the best advantage. Although cattle fed only corn during such a year probably will return a higher profit per head than those fed a limited amount of corn and considerable molasses, the larger number it is possible to feed by using molasses are likely to return larger profits to the individual farmer and to the industry as a whole.

Feeders who make large profits on molasses-fed cattle during a year of feed scarcity should not be misled as to its feeding value in terms of corn or sorghum. When fed to the extent of one-third or more of the grain ration, molasses is approximately 80 per cent as efficient as shelled corn or sorghum in producing a given amount of gain. Another way of expressing the value of molasses is to say that 75 pounds of molasses are equal to one bushel of corn or about 60 pounds of sorghum. Therefore, unless 75 pounds of molasses (or 65

[5] Kansas Station Biennial Report, 1934-1936, p. 62

Table 128

THE VALUE OF SMALL AMOUNTS OF MOLASSES FOR FINISHING CATTLE

Age of Cattle	Calves		Yearlings		2-year-olds		All Tests	
Number of Tests	12		6		7		25	
	Check	Molasses	Check	Molasses	Check	Molasses	Check	Molasses
Av. molasses fed, lbs.	...	1.4	...	2.6	....	3.0	....	2.2
Av. grain eaten (all lots)	9.9	10.1	13.8	12.1	15.9	13.5	12.5	11.6
Av. grain eaten (unrestricted lots)	9.9	10.1	15.1	14.8	17.6	15.2	12.6	12.1
Av. daily gain.	2.02	2.15	2.53	2.42	2.79	2.72	2.36	2.38
Water drunk daily	54.0	56.3	...	...	48.8	47.2	52.3*	53.6*
Feed consumed per cwt. gain								
Grain	491	471	547	496	567	496	509	481
Prot. conc.	98	92	77	80	108	110	96	95
Corn silage	333	311	201	256	840	852	553	549
Hay	90	86	215	215	118	125	129	137
Molasses	..	55	.	124	.	115		88
Selling price per cwt.	$10.72	$10.65	$10.86	$10.67	$10.48	$10.60	$10.69	$10.64

* Average of 17 comparisons made of water consumption.

gallons, since 1 gallon of molasses weighs 11.7 pounds) can be bought for less than a bushel of corn or 60 pounds of sorghum, it is not an economical replacement for large amounts of these grains. Furthermore, *when the lower selling price of the molasses-fed cattle is taken* into consideration, the actual money value of the molasses may disappear altogether (See Table 129.)

Mixed Molasses Feeds. *Comparatively little low-grade molasses* is sold directly to cattle feeders except in the case of feed yard operators The greater percentage is purchased by the manufacturers of mixed feeds and is utilized by them in the preparation of their special manufactured supplements On account of the large quantities of molasses that many of these concerns use, it can be shipped in tank cars or barges at a low freight and handling charge

The principal use of molasses in mixed feeds is to sweeten the product and make it more palatable Sometimes the materials entering the mixed feeds are of inferior grade and would not be consumed in quantity in *their natural state* Although many of these feeds contain nothing but high-grade materials, a few are made up largely of mill screenings, chaffy, lightweight grains, oat hulls; coarse,

Table 129

VALUE OF MOLASSES AS A SUBSTITUTE FOR A CONSIDERABLE PART OR ALL OF THE GRAIN RATION*

Yearling Steers — 150 days

Grain fed to molasses lots was ground to absorb the molasses	Shelled Corn	Cane Molasses	Ground Corn 25% Ground Oats 25% Molasses 50%		Gr. Corn 50% Gr Oats 50% Molasses
Method of Feeding Molasses		Poured on Silage	Poured on Grain and Silage	All Feeds except Silage Machine Mixed	Self-Fed
Av. initial weight, lbs	753	754	753	750	752
Av. daily gain	2 51	2.08	2.57	2.51	2.24
Av daily ration					
Corn or corn and oats	13 9	.....	6 8	5.9	6.8
Molasses	.....	14.3	7 2	6.1	5.6
Soybean-oil meal	1 9	2 9	2.6	2.2	2.6
Corn silage	20 0	22 7	20.0	20 0	20.0
Alfalfa hay	2.0	2 0	2.0	2.9[a]	2.0
Feed per cwt gain					
Corn or corn and oats	516	.....	265	234	278
Molasses	...	642	282	243	251
Soybean-oil meal	74	129	100	88	104
Corn silage	796	1021	778	796	893
Alfalfa hay	80	96	78	117	89
Cost of gain per cwt.	$15 09	$14 85	$13.64	$13 23	$14 76
Selling price per cwt.	18 25	16 00	17.25	16 75	16.50
Shrinkage in shipment, lbs.	41	66	54	72	59
Return above cost of cattle and feed	$69 35	$41.09	$61.83	$54.50	$47.73
Price per ton at which molasses would have been as profitable as corn at $1 12 and oats at 40 cents a bu	...	−$3 25	$11 20	−$7.42	−$26.20
Water drunk daily					
Aug 5–19, lbs	92	108	....	....	....
Aug 22–Sept 6	86	..	....	119	....

* Illinois Experiment Station, Mimeographed Report, 1937.

[a] Hay ground and mixed with grain to help absorb the molasses.

stemmy, or discolored alfalfa; cottonseed hulls; and sometimes ground corn cobs and dried peat. Molasses added to a mixture of such materials not only increases its palatability but also tends to bind the several ingredients more closely together, thereby making it difficult for the purchaser to determine their true nature and quality.

Potatoes. Of the 450 million bushels of potatoes harvested in the United States each year, 5 to 10 per cent are culls which cannot be

marketed profitably for human consumption. During years of abnormally large yields a considerable percentage of the edible potato production may be held off the market to prevent prices from falling to abnormally low levels. Cull and surplus potatoes constitute an important feed for cattle in the important potato-growing areas of the United States. Usually they are considered too bulky in relation to their feeding value to justify shipping them very far from where they were grown.

Raw potatoes, like other roots and tubers, should be considered a carbonaceous concentrate which is diluted with a large amount of water. Consequently, cattle must consume large amounts of potatoes to get enough digestible nutrients to make satisfactory gains. They are low in protein, minerals, and vitamins and, therefore, must be combined with other feeds that supply adequate amounts of these nutrients. High-quality alfalfa hay grown on phosphorus-rich soil is a good source of these nutrients, but the hay must be limited in amount in order not to interfere with a large consumption of potatoes. Fairly satisfactory results have been obtained at the Northwest Branch Station, University of Minnesota, from feeding potatoes and oat straw according to appetite, supplemented with 1 pound of linseed meal per head daily. Yearling steers fed this ration for 196 days made an average daily gain of 1.90 pounds, compared with 2.33 pounds for similar steers given a full feed of grain and alfalfa and brome grass hay. Reducing the potatoes somewhat during the last half of the feeding period and feeding from one-third to one-half a full feed of grain resulted in gains and finish nearly equal to those of the check lot given a full feed of grain. (See Table 130.)

In three experiments at the Northwest Branch Station, potatoes were worth 25 to 70 cents per 100 pounds based on the cost of gains, when grain, hay, and oat straw were valued at approximately $10, $25, and $10 a ton, respectively. Slicing the potatoes reduced their palatability and consumption slightly and, therefore, was of no value. Choking from eating whole potatoes was prevented by nailing a 2 inch by 6 inch plank about 30 inches above the feed bunk to compel the steers to keep their heads down while eating.

Use of Root Crops in Great Britain. Roots such as turnips, mangels, rutabagas, and stock beets possess considerable merit as a feed for finishing cattle as demonstrated by their extensive use throughout the British Isles. There they are an important source of energy, since relatively small amounts of ordinary concentrates are fed, and the roughage supplied is largely chaff and straw.

British farmers usually do not put their cattle into the feedlot

Table 130

THE VALUE OF POTATOES FOR FINISHING CATTLE*

	Yearling Steers, 2 Years (168 days)				Yearling Steers, 2 Years (196 days)		
	Check Lot No Potatoes	Whole Potatoes, Hay	Sliced Potatoes, Hay	Whole Potatoes, Oat Straw	Check Lot No Potatoes	Whole Potatoes, Oat Straw	Whole Potatoes, Oat Straw, Linseed Meal
Av. initial weight, lb	744	754	748	736	683	701	689
Av. daily gain	2.12	2.00	1.72	1.90	2.31	1.57	1.90
Av. daily ration							
Grain mixture†	16.1	8.72‡	9.21‡	8.72‡	15.6		..
Linseed meal					1.0	...	1.0
Alfalfa hay	3.0	3.0	3.0		3.0	.	...
Brome-grass hay	6.5	8.3	9.6	.	4.8	.	...
Oat straw				10.7		8.1	6.6
Potatoes		51.5	48.7	52.9		61.3	61.1
Feed per cwt. gain							
Grain mixture	757	436	536	458	670	. .	. .
Linseed meal				. .	40	. .	51
Hay	448	565	728	. .	340	. .	..
Oat straw				537	..	517	349
Potatoes		2,566	2,795	2,653		3,907	3,219

* Northwest School and Experiment Station, University of Minnesota, Crookston, Minnesota, Mimeographed Reports, unnumbered.

† Grain mixture 1948–1949: 60% barley, 30% oats, 10% linseed meal. 1950–1951: 70% barley, 30% oats.

‡ Grain fed last 84 days.

until they are 2 years old, at which age they have considerable capacity and can handle large quantities of roots daily. It is by no means unusual to feed 60 to 80 pounds of roots per head per day, although even greater amounts are sometimes used. Of 201 lots of cattle fed experimentally in Great Britain from 1833 to 1908, all but 16 received roots, 43 lots consuming 100 pounds or more per head per day. The average daily gain of the root-fed lots was 1.82 pounds, whereas that of the no-root lots was 1.51 pounds.[6]

Best results are obtained from heavy root rations when the feeding period is not overly long. Roots are too bulky to sustain the rate of gain at a satisfactory figure after the cattle acquire a fair amount of flesh. In this respect roots are like corn silage. As a matter of

[6] H. Ingle, "Cattle Feeding Experiments in Great Britain," *Transactions of the Highland and Agricultural Society of Scotland*, 1909.

Table 131

THE VALUE OF DRIED CITRUS PULP AND DEHYDRATED SWEET POTATOES FOR FINISHING CATTLE

	Florida Bull. 454 (Average 2 Trials)			Oklahoma Misc. Publ. 11 and 13 (Average 2 Trials)		
	Ground Snapped Corn	Dried Citrus Pulp	Ground Snapped Corn, 2 lb. Dried Citrus Pulp	Ground Shelled Corn	Dried Sweet Potatoes	Ground Corn 1, Dried Sweet Potatoes 1
Initial weight, lb	608	590	607	507	506	508
Final weight	892	850	883	862	825	877
Total gain	284	260	276	355	319	369
Av daily gain	2.37	2.17	2.30	2.14	1.92	2.22
Av daily ration						
Ground snapped or shelled corn	10.6		2.0	11.3	...	6.2
Corn substitute		7.9	9.0	...	9.0	6.2
Protein concentrate	2.9	2.9	2.9	1.5	1.9	1.7
Sorgo silage			...	9.5	8.8	9.5
Hay	5.8*	5.7*	5.8*	1.0†	1.0†	1.0†
Feed per cwt. gain						
Ground snapped or shelled corn	455	.	87	528	...	279
Corn substitute		365	322	...	478	279
Protein concentrate	124	135	127	71	100	79
Silage	.	.	...	445	478	430
Hay	245*	264*	250*	59†	53†	45†

* Carpet and Bermuda grass hay.
† Alfalfa hay.

factory rate of gain. In two tests made at the Oklahoma station, steer calves full-fed dried sweet potatoes ate considerably less feed and gained more slowly than the check lot fed ground shelled corn. However, a third lot fed equal parts of ground corn and dried sweet potatoes consumed more concentrates and made faster gains than the check lot. Even in this third lot the substitution of dried potatoes for half of the corn ration reduced the net profit the first year because the dried potatoes cost $19 a ton more than corn, and the second year because the potato-fed cattle sold for 50 cents a hundred less than those fed ground shelled corn (See Table 131.)

Animal Fats in Finishing Rations. Fats and oils have a gross energy value which is approximately 2.25 times that of carbohydrates. In recent years animal fats have accumulated in surplus quantities owing to closer trimming of pork carcasses in the packing plants.

and to the advent of synthetic detergents and the resultant decrease in demand for fats by the soap industry. Research with poultry has amply demonstrated that if fats can be bought at prices not much higher than those paid for carbohydrates, more economical broiler rations can be formulated with the use of such fats. The Nebraska station tested two sources of fats, namely, beef tallow and corn oil, as substitutes for corn in steer finishing rations. Table 132 gives the pertinent data. Although the tallow ration contained only about 3 per cent tallow, the steers were each consuming about ¾ pound of added fat daily without digestive disturbances. The steers on the corn oil were difficult to keep on feed. Vitamin A deficiency symptoms developed in the two added-fat lots, undoubtedly owing to the oxidation of the carotene and vitamin A in the ration. The use of an antioxidant in the fat source should prevent this. More experimental work needs to be done before the addition of animal fats to the rations of finishing cattle can be confidently recommended, but it does appear possible that low levels may be successfully used. Levels as high as 10 per cent are definitely to be avoided, since it has been shown that such levels interfere with the normal functioning of the bacterial flora in the paunch.

Table 132

USE AND VALUE OF BEEF TALLOW AND CORN OIL FOR FINISHING CATTLE*

Energy Source Tested	Corn	Beef Tallow	Corn Oil
Number of steers	10	10	10
Av. initial weight, lb.	855	859	852
Final weight, lb.	1,172	1,159	1,113
Av. daily gain, lb.	2.11	2.00	1.74
Daily feed consumption			
Ground shelled corn, lb.	17.1	...	.
Ground ear corn, lb.	...	9.4	9.2
Beef tallow pellets, lb.		12 2†	
Soybean oil meal, lb.	0 9	. .	
Corn oil pellets, lb.	.	.	11 9†
Brome hay, lb.	2 8	2.0	1 8
Vitamin A supp., gm.	2.97	4 03	3.78
Feed cost per cwt. gain, $	27.67‡	26 49‡	31.96‡

* Nebraska Beef Cattle Progress Report 219, 1953.

† Pellets consisted of the *following percentages* of ingredients, by weight: ground corn cobs, 68 14; soybean oil meal, 14.73; blackstrap molasses, 9.20, beef tallow or corn oil, 5.53; urea, 1.31; bonemeal, 1.08; trace mineral premix, 0.01.

‡ Shelled corn, beef tallow, and corn oil were valued at 3, 9, and 15 cents per pound, respectively.

Table 131

THE VALUE OF DRIED CITRUS PULP AND DEHYDRATED SWEET POTATOES FOR FINISHING CATTLE

	Florida Bull. 454 (Average 2 Trials)			Oklahoma Misc. Publ. 11 and 13 (Average 2 Trials)		
	Ground Snapped Corn	Dried Citrus Pulp	Ground Snapped Corn, 2 lb. Dried Citrus Pulp	Ground Shelled Corn	Dried Sweet Potatoes	Ground Corn 1, Dried Sweet Potatoes 1
Initial weight, lb.	608	590	607	507	506	508
Final weight	892	850	883	862	825	877
Total gain	284	260	276	355	319	369
Av. daily gain	2 37	2.17	2.30	2.14	1.92	2.22
Av. daily ration						
Ground snapped or shelled corn	10 6		2 0	11.3	. .	6 2
Corn substitute	.	7.9	9.0	...	9.0	6.2
Protein concentrate	2 9	2.9	2.9	1.5	1.9	1.7
Sorgo silage			...	9.5	8.8	9.5
Hay	5.8*	5.7*	5 8*	1.0†	1.0†	1.0†
Feed per cwt gain						
Ground snapped or shelled corn	455		87	528	...	279
Corn substitute		365	322	...	478	279
Protein concentrate	124	135	127	71	100	79
Silage		.	. .	445	478	430
Hay	245*	264*	250*	59†	53†	45†

* Carpet and Bermuda grass hay

† Alfalfa hay.

factory rate of gain. In two tests made at the Oklahoma station, steer calves full-fed dried sweet potatoes ate considerably less feed and gained more slowly than the check lot fed ground shelled corn. However, a third lot fed equal parts of ground corn and dried sweet potatoes consumed more concentrates and made faster gains than the check lot. Even in this third lot the substitution of dried potatoes for half of the corn ration reduced the net profit the first year because the dried potatoes cost $19 a ton more than corn, and the second year because the potato-fed cattle sold for 50 cents a hundred less than those fed ground shelled corn. (See Table 131.)

Animal Fats in Finishing Rations. Fats and oils have a gross energy value which is approximately 2.25 times that of carbohydrates. In recent years animal fats have accumulated in surplus quantities owing to closer trimming of pork carcasses in the packing plants,

Protein Requirements. In Chapter 8 it was shown that protein requirements for beef cattle are expressed on a quantitative rather than a qualitative basis. That is to say, protein is protein to a ruminant provided the sources are of equal digestibility, and it matters little whether or not the protein may be deficient in certain amino acids. It was further shown that non-protein nitrogenous sources can be used to satisfy at least part of the protein needs of cattle. In the nutrient requirement tables in Chapters 10, 11, and 15, protein requirements are expressed in four ways: (1) percentage of total protein in the ration, (2) percentage of digestible protein in the ration, (3) daily requirements of total protein, and (4) daily requirement of digestible protein per head. There are still other ways of expressing protein requirements for feeder cattle, some of which are actually more convenient to use in practice than the tables referred to above, although they may be somewhat less exact.

Methods of Expressing Protein Requirement in Finishing Rations. (1) *Total Protein Requirement.* Finishing rations should contain between 10 and 11 per cent total protein, or they should furnish between 1.3 and 2.9 pounds of total protein daily depending upon the size of the animal. When computing daily total protein requirements for a drove of feeder cattle it is often more convenient, although less accurate, to express them on the basis of amount required daily per 1,000 pounds live weight of animal. In this case 2.5 to 3.0 pounds may be used as the requirement. Actually calves require somewhat more protein per unit of weight than do older cattle, but because they usually consume more feed per unit of weight the percentage protein in the ration does not need to be increased as much for calves as one might think it would be.

(2) *Digestible Protein Requirement.* The digestible protein in a ration is, of course, that portion of the protein which is actually digested and made available to the bacterial flora in the paunch or to the animal itself. Naturally it is less than the total protein figure and the extent to which it is less depends upon the quality of the ration. As shown earlier, digestible protein for cattle represents approximately 60 per cent of the total protein in high-roughage rations and 75 per cent of the total protein in more concentrated rations such as those fed to finishing cattle. Fiber content of a protein concentrate or of a ration is a fairly good guide for evaluating the digestibility of the protein in the ration, but this rule is not infallible. Digestible protein requirements, when expressed as per cent digestible protein in the ration, range from 7.5 to 8.2 per cent, with the younger cattle again having the higher requirement. When requirements are expressed as daily

chapter 17

PROTEIN REQUIREMENTS OF FEEDER CATTLE AND HOW TO SUPPLY THEM

One of the first discoveries made by early investigators of animal feeding was the need of the animal body for the complex organic compounds called proteins. The important thing about proteins is that they contain nitrogen, an element indispensable to all animal life. Nitrogen is necessary for the building and repair of nearly all the tissues of which the animal body is composed. The lean portions of the body, the skin and its modifications, and the connective tissues consist almost entirely of protein materials which have been elaborated and built up from the nitrogenous compounds in the feeds consumed by the animal Protein feeds not only contain nitrogen, but they also are rich in phosphorus, an element that is highly necessary for the growth of the bones.

Animals use the proteins in their rations chiefly to build and repair tissues within their bodies, as just indicated. Apparently it is not possible for ration protein in excess of immediate rumen bacterial and body requirements to be stored as protein to satisfy future needs. Instead, after the immediate needs for this nitrogenous material are satisfied, the nitrogen from the excess is excreted in the urine and lost except for whatever fertilizer value it may have. The non-nitrogenous fraction of the excess ration protein can be utilized as energy in meeting maintenance requirements, or it can be converted to fat and stored the same as other energy consumed in excess of maintenance requirements. Since protein feeding stuffs are relatively expensive it is evident that their use for the production of fat and energy is not economical. It is therefore important for the cattle feeder to have an understanding of the protein requirements of feeder cattle of different ages, kept under different conditions, in order that the proper amount of this nutrient may be supplied.

fed by 8. Roughages consisting of mixtures of grasses and legumes generally supply only half as much supplemental protein as straight legume roughages. Consequently each pound of such air-dry roughage contributes the equivalent of $\frac{1}{8}$ pound of protein concentrate.

(4) *Ratio of Protein Concentrate to Grain.* Protein concentrates are often mixed with the grain portion of the ration prior to feeding; for example, when self-feeding or when feeding with automatically metered mixing equipment. In these situations it is desirable to know what proportions of protein concentrate and grain to mix in order to insure correct daily consumption of protein concentrate. In other words, a given ratio is maintained between the weight of corn and the weight of the protein feed used. The advantage of such a method is its simplicity. The feeder is much more likely to know how much corn he is feeding than he is to know how much the steers really weigh. Its chief disadvantage is that the same ratio is likely to be maintained throughout the feeding period. The ration is therefore no more palatable toward the end than it was at the beginning. This trouble, however, can be easily overcome by gradually narrowing the ratio as the feeding period progresses. Based on such a plan, the ratios in Table 133 will be found fairly satisfactory.

The comparatively narrow ratio during the first part of the feeding period, when a non-legume roughage is used, is necessary because of the small amount of corn that is commonly fed at this stage of the finishing process. When a legume roughage is used the condition is reversed, since the large amount of clover or alfalfa hay consumed during the first weeks furnishes an adequate supply of protein.

If ground ear corn is fed instead of shelled corn, the ratio of protein concentrate to grain should be narrowed somewhat, but if higher protein content grains such as sorghum or barley are used, then the ratio should be widened. When full feeding grain to cattle on legume pasture, the ratio may be widened still further, even as wide as 1:15

Table 133

RATIO BETWEEN NITROGENOUS CONCENTRATE AND CORN FOR FULL-FED STEERS

Ration	Period	Two-year-olds	Yearlings	Calves
Corn—	1st third	1:6	1:5	1:4
Non-legume Roughage	2d third	1:8	1:7	1:6
	Last third	1:7	1:6	1:5
Corn—	1st third	None	None	1:10
Legume Hay	2d third	None	1:10	1:8
	Last third	1:10	1:8	1:7

FIG. 73. Legume-grass mixtures such as this one, consisting largely of red clover and timothy, produce hay which can supply appreciable amounts of protein in the rations of beef cattle. (University of Illinois.)

requirements of digestible protein, 1.0 to 2.2 pounds are required daily per head, or approximately 2.0 to 2.5 pounds per 1,000 pounds of live weight.

(3) *Daily Protein Concentrate or Legume Roughage Equivalent.* This expression refers to the supplemental protein needed to balance the grain or carbonaceous concentrate portion of the finishing ration. Corn, for example, when full-fed contributes only about half of the protein required by cattle being fed finishing rations. If the roughage portion of the ration is non-leguminous, the protein content of the ration will not be improved Consequently all finishing rations consisting of carbonaceous concentrates and non-legume roughage require supplemental sources of protein. Generally speaking, 2 pounds of a high-protein content concentrate (35 to 50 per cent total protein) are required daily to balance finishing rations if no leguminous roughage is included. Each pound of air-dry legume roughage such as alfalfa or clover hay reduces this protein concentrate requirement by ¼ pound. The pounds of legume silage consumed should be reduced to an air-dry basis by dividing the amount consumed by 3 in determining its contribution of supplemental protein. Legume green chop or soilage can be reduced to an air-dry basis by dividing the amount

Table 134

RELATIVE COST OF DIGESTIBLE PROTEIN IN FARM-GROWN LEGUME HAY AND IN PROTEIN CONCENTRATES*

	Digestible Nutrients per Ton		Approximate Farm Value per Ton	Approximate Value of Carbohydrates and Fat†	Net Cost of Digestible Protein	Net Cost of Digestible Protein per Pound
	Protein (lb.)	Carbohydrates and Fats (lb.)				
Alfalfa hay	218	796	$ 20.00	$10.87‡	$ 9.13	$0.042
Clover hay	144	892	20.00	11.95‡	8.05	0.056
Soybean oil meal (50%)	928	660	100.00	13.20	86.80	0.094
Soybean oil meal (43%)	738	834	80.00	16.68	63.32	0.086
Cottonseed meal (41%)	666	708	90.00	15.36	74.64	0.112
Linseed meal (37%)	652	908	80.00	18.16	61.84	0.095
Wheat bran	266	1,072	50.00	21.44	28.56	0.056

* Calculated from Tables of Digestible Nutrients in Morrison's *Feeds and Feeding*, 22nd edition, 1956.

† In determining the money value of the digestible carbohydrates, an arbitrary value of $0.02 per pound was assumed. This is the approximate cost of the digestible carbohydrates in corn at $1.12 per bushel:

1 bushel (56 lb.) corn contains:

3.7 lb. digestible protein @ 8¢ = $0.296

41.1 lb. digestible carbohydrates @ 2¢ = 0.822

Total value of nutrients in 1 bushel of corn = $1.118

‡ Arbitrarily decreased one-third because of the higher percentage of fiber in roughages.

during the early pasture season, narrowing to 1:10 or 1:12 as the pasture matures.

(5) *Nutritive Ratio.* This method of expressing protein requirements is probably being used less and less as more reliance is placed on the newer concepts of ruminant nutrition. Nutritive ratio is an expression of the proportion of digestible protein to digestible non-nitrogenous nutrients (including fat multiplied by 2 25). Rations fed to finishing cattle should have nutritive ratios ranging from 1:6 to 1:6.5 for 400-pound calves to 1:9 for heavy 2-year-old steers.

Sources of Protein. While all ordinary feeding stuffs contain some protein, the amount furnished by the cereal grains, usually the principal component of finishing rations, is so small that other feeds containing a relatively high percentage of protein must be supplied if satisfactory results are to be obtained. Because of their nitrogen content, protein feeding stuffs are spoken of as "nitrogenous feeds," and are divided according to their nature into nitrogenous concentrates and nitrogenous roughages. In the main, the concentrates consist principally of the by-products that result from the milling of cereal grains and from the extraction of oil from seeds that have a high percentage of fat. The more commonly known feeds of this class are linseed (flax) meal, cottonseed meal, soybean meal, gluten (corn) meal, and wheat bran.

The nitrogenous roughages are represented by the different legume hays and silage and are, of course, entirely farm-grown except for dehydrated legumes Clover, alfalfa, soybean, cowpea, and lespedeza are the principal legume hays used in cattle feeding. In connection with nitrogenous roughages, green legume forage such as alfalfa, red, alsike, and sweet clover pastures should be mentioned. Steers with access to such grazing obtain a large percentage of the protein needed from these pasture crops For mature cattle, no additional protein is likely to be required if the pasture is the only feed consumed

The major portion of the protein needed by beef cattle should be furnished in the form of legume roughage grown on the farm where the cattle are fed, because of the price relationships shown in Table 134. Furthermore, in this way it is possible to realize one of the purposes for which cattle are kept, namely to furnish a means of marketing legume crops without losing much of the nitrogen which they secure from the air.

Despite the large amounts of high-protein feeds produced in this country they usually fall far short of being enough to balance the enormous tonnage of grains, straw, stover, and low-protein mill feeds that are used annually in meat, egg, and dairy production. Swine and

periments reported in Table 135. In these trials the use of the protein feeds brought about a slight increase in the consumption of corn and produced slightly larger daily gains. In all three trials, however, the feed costs were increased to the extent that the use of the supplement would have been unprofitable had not the cattle receiving it sold for approximately 25 cents a hundred more than those which were fed only corn and legume hay.

Somewhat better results may be expected in calves and yearlings since their need for protein is greater. (See Table 136.) Also, younger cattle have less capacity than older animals and therefore will not ordinarily eat enough legume hay to secure as much protein from that source as they need.

Despite these facts, however, it should not be inferred that the profit realized from feeding calves is always increased by the use of purchased concentrates. The gains made are larger, but probably more costly. However, under normal market conditions the superior condition and finish produced by the protein concentrate result in an advance in selling price sufficient to cover the increased cost of gains with something left over to add to the profit.

Table 135

EFFECT OF ADDING A PROTEIN CONCENTRATE TO A RATION OF CORN AND LEGUME HAY FOR TWO-YEAR-OLD STEERS

	Iowa Mimeo. Report, 1922–1923		Nebraska Bull. 345		Nebraska Bull. 345 (Average 2 Trials)	
Legume Hay Fed	Clover Hay		Alfalfa Hay		Alfalfa Hay	
Supplement Fed	None	Linseed Meal	None	Linseed Meal	None	Cottonseed Meal
Av. daily gain, lb.	2.33	2.56	2 31	2.26	2 32	2 57
Av. daily ration						
Shelled corn	19 9	22 0	17.0	17.6	17.2	17.7
Protein concentrate	.	1.5		1.7	.	1.7
Legume hay	8 9	7.1	10 5	8.7	11.0	10.4
Feed per cwt. gain						
Concentrates	857	919	775	856	735	732
Legume hay	381	278	455	388	496	422
Feed cost per cwt. gain	$12.74	$13.44	$8 08	$9 68	$12 91	$13 02
Selling price per cwt.	9 75	10.00	8 00	8 00	10 75	10 95
Net return per head (including hog gains)	3 48	5 48	13 71	7.44	23.02	26 63

poultry are unable to use legume roughages to any extent; high-protein feeds must therefore be included in their rations regardless of price, if a satisfactory level of production is to be maintained. Beef cattle, on the other hand, can utilize large amounts of roughage and often derive the major portion of their protein requirements from legume hay and pasture. These farm-grown sources of protein enable beef producers to finish their cattle successfully with relatively little purchased protein concentrate if they keep the recommended percentage of their farm acreage in legume crops.

Proof of the Need for a Protein Concentrate. In discussing the matter of establishing the need for a protein concentrate under practical feeding situations, the type of roughage fed is of primary importance. For this reason research data are presented which take the different types of roughage into account.

1. *When the Roughage Is Legume Hay.* Many feeders consider that cattle receiving a ration of grain and alfalfa or clover hay have little or no need for a protein concentrate. However, most experimental feeding trials show that the addition of a small amount of an oilseed meal to such a ration usually results in a noticeable increase in the average daily gains. Whether the use of such material proves to be financially profitable depends upon the relative costs of the nitrogenous concentrate and the feeds that it displaces or saves, as well as upon the amount of premium that highly finished cattle command on the market. Under normal conditions the use of a protein supplement would not be justified during the first half of the feeding period while the cattle are consuming large amounts of legume hay. During the last half, however, a small amount of protein concentrate usually is advisable, since the amount of hay eaten at this time is seldom enough to furnish the amount of protein required to maintain the proper ratio between protein and carbohydrates for the most effective action of the rumen bacteria.

Apparently one of the benefits derived from adding a protein concentrate to a ration of grain and legume hay during the last half of the feeding period is its effect upon the appetites of the cattle, which tend to become sluggish as the cattle approach market finish. Most of the protein concentrates are highly palatable. Consequently, not only is the protein concentrate itself consumed, but the cattle often eat more grain and hay than they would eat if the protein feed were omitted. Faster daily gains are the result.

The results usually obtained from adding a protein concentrate to a corn-legume hay ration are well illustrated by two of the three ex-

A study of Table 137 shows the following advantages of adding a nitrogenous concentrate to a badly unbalanced ration:

a. A larger consumption of feed is realized.
b. Larger daily gains are made by the animals.
c. The amount of feed required per pound of gain is materially reduced.
d. A higher price is obtained for the finished cattle.

3. *When Only Part of the Roughage Is Legume Hay*. Unless nearly all of the roughage ration consists of a good grade of legume hay, the feeding of a nitrogenous concentrate is usually advisable Although it sometimes happens that an unusual demand for the common protein feeding stuffs forces their price so high that their use materially increases the cost of gains, the increase in selling price that results

Table 137

EFFECT OF ADDING A PROTEIN SUPPLEMENT TO A RATION CONTAINING NO LEGUME HAY

	Indiana Bull. 115		Illinois Station Mimeo. Rpt, 1928		Oklahoma Station Mimeo Rpt, 1930	
	Corn Stover and Oat Straw (2-year-olds)		Corn Silage and Oat Straw (Calves)		Prairie Hay (Calves)	
	No Supplement	Linseed Meal	No Supplement	Cottonseed Meal	No Supplement	Cottonseed Meal
Av. daily gain, lb.	1.30	1.78	1 51	2.44	1 40	2.22
Av. daily ration						
Corn	17.6	20.5	9 32	11.34	8 70	9 33
Protein supplement	....	1.5	....	1.64	....	1.46
Corn stover or silage	....	....	6 9	8 1	. .	.
Hay or straw	....	....	0.63	2 0*	3.47	5.30
Limestone	....	....	0.10	. .	0 17	0 19
Feed per cwt. gain						
Concentrates	1,345	1,148	618	528	615	486
Roughage	586	393	497	415	245	233
Feed cost per cwt. gain	. .	.	$10 78	$10 31	$9.37	$8.17
Selling price per cwt	$5 00	$5 35	$12 60	$13.65	$10.00	$11.50

* Alfalfa hay.

Table 136

NEED OF CALVES FOR A PROTEIN CONCENTRATE WITH CORN AND ALFALFA

Supplement Fed	Illinois Mimeographed Report (1914)		Kansas Mimeographed Report (1918)		Nebraska Bull. 345, 1943	
	None	Cottonseed Meal	None	Linseed Meal	None	Cottonseed Meal
Av. daily gain, lb	1.97	2.17	2.29	2.37	2.41	2.54
Av. daily ration						
Shelled corn	12.4	11.0	10.5	9.9	11.1	10.6
Protein concentrate	..	2.2	....	1.7	....	1.8
Hay	6.2	6.1	10.3	9.8	4.4	4.6
Feed per cwt. gain						
Concentrates	621	605	457	488	460	486
Hay	319	283	450	413	182	180
Feed cost per cwt. gain	$9.14	$9.07	$16.72	$17.40	$7.12	$7.78
Selling price per cwt.	9.80	10.00	16.00	16.25	10.25	10.50
Net return per head	7.41	8.86	28.89	27.13	12.07	13.33

2 *When No Legume Hay Is Fed.* No informed progressive cattleman considers it wise to try to finish cattle without using some kind of nitrogenous feeding stuff in the ration. However, there are hundreds of men who, finding themselves without legume hay of any kind, still attempt to make cattle ready for market by using only such feeds as corn, corn silage, prairie hay, and straw. With the unbalanced rations that are bound to result from these wholly carbonaceous materials, it is not surprising that the cattle put on weight very slowly and with a wasteful use of feed. So inefficient is a ration of this kind that its use can never be recommended except at such times as the price of nitrogenous feeding stuffs is extremely high compared with corn, and then only for mature, low-grade steers or cows that are being given a short feed. With such a ration it is almost impossible to put yearling or 2-year-old cattle in choice condition unless the feeding period is unduly prolonged. If it is impossible or impracticable to purchase a nitrogenous feeding stuff to supplement these farm-grown feeds, the grain had better be sold and the straw and stover returned to the land and plowed under. However, if a sufficient amount of a nitrogenous concentrate is fed to supply the necessary protein, the results secured from grass hays and straw are not greatly inferior to those from legume hay.

Table 139

PERFORMANCE OF YEARLING STEERS SELF-FED GROUND EAR-CORN ON LEGUME-GRASS PASTURE WITH OR WITHOUT SUPPLEMENTAL PROTEIN*

	Protein Supplement†	*No Protein*
Number of steers	15	15
May 7–July 30, 1957, 84 days		
Av. initial weight, lb.	691.3	696.7
Av. daily gain, lb.	2 83	2 17
Av. daily feed consumption, lb.	17.11	13.65
Cost per cwt. gain, $	16 85	14 67
July 31–August 27, 28 days		*Protein Added*†
Av. initial weight, lb.	928.7	879.3
Av. daily gain, lb.	2.33	2.95
Av. daily feed consumption, lb.	13.45	23.55
Cost per cwt. gain, $	14.40	18 25
Summary—entire 112-day period		
(May 7–August 27, 1957)		
Av. final weight, lb.	994.0	962 0
Av. daily gain, lb.	2.70	2 31
Av. daily feed consumption, lb.	16 20	16 13
Cost per cwt. gain, $	*15.12*	*15 87*

* Illinois Cattle Feeders Day Report, 1957.
† Soybean oil meal added in the ratio of 1:12.5.

season. Table 139 shows the effect upon rate and cost of gain, and daily consumption of feed, of adding a protein concentrate to a full feed of ground ear corn. Whenever protein concentrate was included, more corn and less pasture was consumed. The feeding of protein concentrate throughout the summer, rather than during the late summer only, proved profitable because of the higher rate of gain and a slightly lower cost per hundredweight of gain.

The Use of Protein Concentrates as Conditioners or Appetizers. In addition to supplying much-needed protein, these concentrates have a certain value as appetizers and conditioners. That is, their use stimulates the appetites of the cattle and causes them to eat more feed than they would otherwise consume. The result is a sleek, thrifty appearance not altogether accounted for by the more rapid gains made. Nearly all of the common protein concentrates are highly palatable. Not only does the introduction of 1 or 2 pounds of oilseed meal into a ration usually cause no lessening of the amounts of the

Table 141

VALUE OF DIFFERENT AMOUNTS OF PROTEIN CONCENTRATES FOR FEEDER CALVES
(Fed in Dry Lot)

	Oklahoma*—Av. of 4 years 1948–52 (Calves)			Ohio†—Av. of 2 years 1934–36 (Calves)			Kansas‡			
Critical Feeds	Cottonseed Cake Alfalfa Hay			Mixed Supplement Mixed Hay, Corn Silage			Cottonseed Cake Alfalfa Hay			
Av. Prot. Concentrates per Day, lb.	0.5	1.0	1.5	0.8	1.6	2.4	0.5	1.0	1.5	2.0
Av. daily gain, lb.	1.98	2.08	2.17	1.99	2.20	2.21	1.98	2.06	2.07	2.12
Feed per cwt. gain, lb.										
Concentrates	588	593	579	609	593	599	515	519	539	550
Dry roughage	51	48	46	85	77	77	101	97	97	94
Silage	346	331	316	351	319	317	402	442	438	432
Feed cost per cwt. gain, $	19.74	20.03	19.71	10.42	10.30	10.60	8.66	8.91	9.44	9.79
Selling price per cwt., $	30.38	30.73	31.06	11.40	11.95	12.15	10.00	10.35	10.25	10.50
Profit per head, $	22.61	26.45	31.71	17.55	25.25	24.81	7.79	9.17	6.62	6.28

* Oklahoma Bulletin B-428.
† Ohio Bimonthly Bulletins 179 and 186.
‡ Kansas Circular 105.

Table 140

Effect of Protein Concentrate upon Consumption of Other Items of the Ration (Dry Lot)

(*Average of 25 Experiments*)

	Average Daily Ration			
	Corn (pounds)	Protein Concentrate (pounds)	Dry Roughage (pounds)	Corn Silage (pounds)
Lots fed no protein concentrate	14.3	...	5.5	8.6
Lots fed protein concentrate	14.2	2.0	5.3	8.9

other feeds eaten, but it *often* results in a noticeable increase in the consumption of the other components, particularly of those materials with which the protein supplement is fed. In this respect the supplement acts as a "seasoner" or appetizer, much like salt and sugar in the human diet. Naturally the greater consumption of all feeds results in a substantial increase in the rate of gains.

The "conditioning" effect of these feeds is probably largely due to their beneficial effect upon the digestive tract. Nearly all the common protein concentrates have a mild laxative effect and serve to keep the digestive system in good order, thereby adding much to the health and well-being of the animals. Moreover, the balanced ration that results from their use makes for more effective nutrition.

Different Amounts of Protein Concentrate Compared. In the early years of experimental beef-cattle feeding, the practice was to feed 2 to 3 pounds of protein concentrate per head daily to 2-year-old steers after they were on full feed, even though they were fed considerable legume hay. For example, the average daily ration of a drove of 2-year-old steers fed at the Indiana station during the winter of 1910–1911 was approximately 23 pounds of shelled corn, 3⅓ pounds of cottonseed meal, and 10 pounds of clover hay after the first 60 days. Such amounts of protein concentrates were soon found to be too large for the most economical gains and they were gradually reduced. In fact, the results of many feeding experiments subsequently carried on have indicated the need for less and less protein concentrate in the ration of finishing cattle. Today less than half the amount fed in the Indiana experiment mentioned previously is the amount recommended for mature steers fed a liberal amount of legume hay.

Results of more recent experiments with younger cattle are shown in Table 141. It has, of course, long been known that young cattle

daily. Since 4 pounds of legume hay contain approximately the same amount of digestible protein as 1 pound of high-quality protein concentrate, the following simple rule should be sufficiently accurate for practical feeding operations:

> To cattle fed no legume hay
> Feed 2 pounds of protein meal per day,
> But for each pound of hay you feed
> One-fourth pound less of meal they'll need.

The application of this simple rule to full-fed steers nearly always results in their getting an amount of digestible protein well within the limits of the requirements given in the requirement tables presented earlier.

Protein Concentrates as Substitutes for Corn. It occasionally happens that cottonseed or soybean-oil meal is cheaper per pound than shelled corn. At such times cattlemen are likely to feed large amounts of these concentrates in an attempt to cheapen the ration by replacing part of the grain. A study of Table 142 discloses that protein concentrates fed in excess of the amount needed for their protein content as a rule replace their weight of corn in producing a pound of gain. Cattle fed a generous amount of protein often command a sufficient premium when marketed to justify replacing 20 to 30 per cent of the grain ration with a protein concentrate. even though corn is slightly cheaper on a pound or ton basis.

require more protein concentrate in proportion to their weight than do older cattle. However, feeding experiments show that there is very little difference in the requirements per head of cattle of different ages when all are fed appropriate amounts of roughage of the same type, that is, legume or non-legume. Knowledge of this fact has greatly simplified the feeding of cattle, since the same thumb rules for supplying protein may be applied to cattle of all ages.

In the light of the facts discussed in the foregoing paragraphs and the information presented in the accompanying tables it appears that a rule for feeding protein concentrates to full-fed cattle need take into account only one factor—the amount of legume roughage consumed

Table 142

Value of Feeding an Excess Amount of Protein Concentrate to Replace Part of the Corn Ration of Finishing Cattle

	Illinois Mimeo. Rept., April 18, 1947* (2-Year-Old Steers)			Illinois Mimeo. Rept., 1927–28 (Calves)		Oklahoma Mimeo. Circ. 58, 1940† (Calves)	
	Soybean Oil Meal			Cottonseed Meal		Cottonseed Cake	
Av. Protein Concentrate per Day	2.3	3.9	6.4	1.6	4.2	2.0	7.0
Av. daily gain, lb.	2.75	2.93	2.89	2.44	2.57	2.23	2.24
Feed per cwt gain, lb.							
Shelled corn	595	534	442	461	324	451	225
Protein concentrate	85	113	220	67	162	88	312
Total concentrate	680	647	662	528	486	539	537
Dry roughage	150	141	143	82	317	515	514
Silage	...	...	...	333	78	...	...
Feed cost per cwt. gain, $	11.18	11.10	11.36	10.31	10.65	6.78	7.71
Selling price per cwt., $	15 00	15.25	15.40	13.65	13.60	9.87	9.83
Net return per head, $	14.08	18.72	19.42	29.52	28.15	20.67	13.68
Feed cost per unit, $							
Shelled corn per bu.	0.80			0.84		0.57	
Protein concentrate per ton	36.00			50.00		29.00	

* 80-day trial.

† Average of 3 tests.

Table 143

SUPPLY OF PROTEIN FEEDSTUFFS SUITABLE FOR LIVESTOCK FEEDING*

Protein Feeds	Amount Fed in U.S. 1945 tons (000)	1954 tons (000)	Wholesale Price per Ton at Leading Market 1954 ($)
1. *Milling by-products*			
Wheat mill feeds	4,896	4,567	...
Wheat bran	...	...	41.10
Gluten feed and meal	802	1,005	50.60
Rice mill feeds	155	303	
Brewers' dried grains	213	238	48.50
Distillers' dried grains	326	251	63 80
Dried and molasses beet pulp†	218	558	
Alfalfa meal	1,192	1,320	50 60
Total	7,802	8,242	
2. Oilseed cake and meal			
Cottonseed	1,433	2,405	69 70
Soybean	3,655	5,426	71.50
Linseed (flax)	563	486	71 15
Peanut	90	18	73 80
Copra (coconut)	69	182	66.25
Total	5,810	8,517	
3. Animal proteins			
Tankage and meat scraps	745	1,073	84.70
Fish meal	194	319	162.75
Dried milk	100	135	
Total	1,039	1,527	

* U.S.D.A. *Agricultural Statistics, 1956.*

† Used in commercial protein supplements but not itself a protein feed

residue to commercial feed companies and farmers as soybean oil meal. Since soybeans direct from the combine have a protein content of more than 35 per cent, they are sometimes fed in the form of whole or ground beans as a farm-grown protein concentrate This practice is especially common if the beans have a high moisture content or are discolored as a result of weather damage, which might cause them to have a low market value. Ordinarily, however, the market price of sound beans is too high to justify their use as feed

Soybeans not only contain a high percentage of protein, but also a high percentage of oil The fat content, depending somewhat on the variety of beans, varies from 15 to 20 per cent When soybeans

chapter 18

THE PRINCIPAL PROTEIN CONCENTRATES USED IN CATTLE FEEDING

Almost all of the common protein concentrates that are used in cattle feeding are by-products of the cereal and vegetable-oil milling industries. Bran and gluten meal are obtained from the cereal mills, whereas cottonseed meal, linseed meal, and soybean meal are by-products of the oilseed processing industry. Table 143 gives a breakdown of protein concentrate supplies for all livestock feeding. In addition to these feeding stuffs, which must be purchased by cattlemen as straight meals or as mixed supplements, there are the unprocessed seeds of a few leguminous plants such as the soybean, which are used to some extent in supplying the protein needs of feeder cattle.

Undoubtedly a larger percentage of cattle feeders feed commercially mixed or "fortified" supplements each year, but data bearing on the extent of this changeover are not available. Non-protein nitrogenous materials such as urea are serving as extenders of the protein concentrate supply by their use as partial substitutes for the oilseed meals. A review of the characteristics, processing methods, and comparative value of the principal protein concentrates used in cattle rations should assist feeders in making the proper choice from among the various concentrates available. However, changing price conditions (largely due to variations in supply), the quality of the remainder of the ration being fed, and the differences in processing methods used, all tend to make it unwise to set forth hard and fast rules as to the relative value of protein concentrates.

Soybeans and Soybean Meal. Although soybeans were almost unknown in many sections of the United States before 1920, they now constitute one of the major crops, especially in the Corn Belt, as shown in Figure 74. Approximately 400 million bushels of soybeans are harvested annually in the United States, 90 per cent of which are sold to milling companies which extract the valuable oil and sell the

are fed in sufficient quantities to supply the protein needed to balance a full ration of corn, the amount of oil consumed is considerably greater than can be utilized by the animals. Scouring, or at least a marked looseness of the bowels, is very likely to result, particularly if the cattle are fed a rather liberal allowance of beans for a considerable length of time. Moreover, the presence of the oil apparently detracts from the palatability of the beans since the cattle seem to tire of them after eating them for a few months.

Soybean oil is a valuable commercial product, which is used in the manufacture of paints and varnishes as well as in the preparation of various edible products. In the extraction of the oil the beans are finely ground and heated and the oil is either pressed out by mechanical presses or dissolved out with a chemical solvent. If the oil is pressed out the residue is called "old process" soybean oil meal; if it is dissolved out the residue is termed "solvent" or "new process" meal. Two types of presses are used in making old process meal—hydraulic and expeller presses. Consequently, old process meal is often called "hydraulic meal" or "expeller meal," according to the type of press used in extracting the oil. The meal is subjected to very high temperatures in the screw-like expeller presses and as a result has a slightly burnt or "toasted" appearance and flavor not possessed by hydraulic or solvent meal unless it is given a special "toasting" treatment after the oil has been removed. Toasted soybean oil meal is more valuable than untoasted meal for both swine and poultry but has little if any advantage for beef cattle. In fact, there is some evidence that the high temperatures to which the meal is subjected during toasting depress the digestibility of the protein slightly. This problem is not really of much practical importance, since most soybeans are now solvent-processed.

Soybean oil meal has the highest protein content of any feed that is available in quantity for beef cattle feeding, namely 41 to 50 per cent. Because of its ready availability and usually comparatively low price per unit of protein, it is the most common "straight" protein concentrate purchased by Corn Belt cattle feeders to supply the protein needed by feeder cattle. Soybean oil meal is of less importance in the South, Southwest, and West where cottonseed meal is highly competitive in price.

In chemical composition, soybean oil meal is quite similar to cottonseed meal. Experiments indicate that it is nearly equal to cottonseed meal in feeding value. For many years some feeders complained that soybean oil meal was too laxative for cattle being fed a full feed of shelled corn and legume hay, but, with the adoption by milling com-

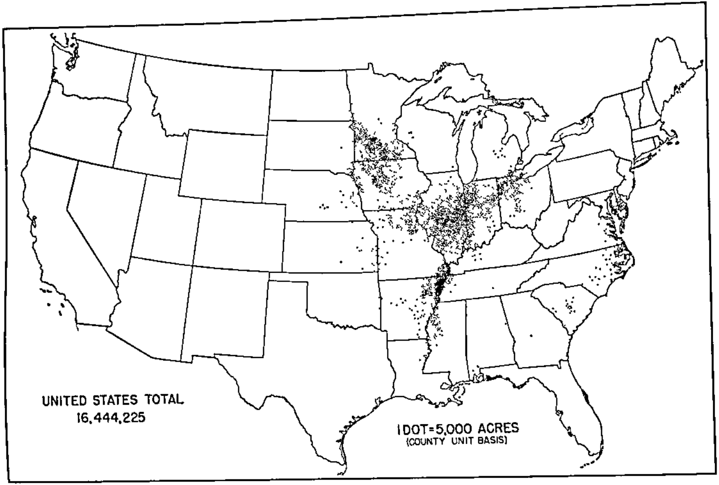


FIG. 74. The principal soybean-producing areas of the United States, 1954. (U. S. Department of Commerce.)

Table 145

COMPARATIVE VALUE OF SOYBEANS, SOYBEAN OIL MEAL, AND COTTONSEED MEAL FOR FINISHING CATTLE

	Illinois Experiment Station Mimeo. Report, 1926–1927				Iowa AH Leaflets 158 and 159		Indiana Bull. 330, 1929	
	1 Trial with Calves				2 Trials with Yearlings		2 Trials with 2-Year-Old Steers	
	Ground Soy-beans	Whole Soy-beans	Soybean Oil Meal	Cotton-seed Meal	Soybean Oil Meal	Cotton-seed Meal	Whole Soy-beans	Cotton-seed Meal
Av daily gains, lb.	2.11	2 26	2.36	2 35	1.78	1.85	2 51	2 29
Av. daily ration								
Shelled corn	8.5	9 0	9.1	10.1	11 0	11.30	12.4	12 3
Protein concentrate	1.3	1 3	1.4	1.5	1 3	1.5	2 3	2 3
Corn silage	8.1	8.1	8.1	8.1	12 0	12 0	24.1	26 2
Legume hay	2 0	2.0	2 0	2.0	1.6	1.6	3.5	3.7
Feed per cwt. gain								
Shelled corn	401	395	387	428	594	611	492	538
Protein concentrate	60	59	57	63	76	78	91	100
Corn silage	385	358	344	343	677	649	961	1,146
Legume hay	95	88	85	85	92	87	139	162
Selling price per cwt.	$10.85	$11.15	$11.60	$11.85	$11 15	$11 15	$9 35	$8 95
Gain of hogs per steer, lb.	39	28	24	38			67	50

cheaper and more readily available because it is more easily made and is in great demand for feeding swine, poultry, and dairy cattle. However, pea-size cake or pellets are much better for feeding with shelled corn, and pellets or cake 1 to 2 inches in size are recommended for use in the range area where the feed is frequently scattered on the ground.

Although whole soybeans are noticeably inferior to soybean meal, they make a fairly satisfactory supplement when carefully fed in moderate quantities. They appear to be more satisfactory for older cattle than for calves, probably because older cattle are fed for a shorter time and are given more roughage. There is some evidence that the feeding of corn silage with whole soybeans or with soybean oil meal tends to overcome the laxative effects sometimes caused by these feeds. For example, steer calves fed 2 5 pounds of soybean oil meal per head daily at the Iowa station went off feed and scoured badly after the silage was reduced by one-half at the end of 210 days of feeding.[1] This theory may explain the unusually good showing made by 2-year-old steers fed whole soybeans in the Indiana experiments, since the grain rations were to some extent restricted and relatively large amounts of silage were fed. (See Table 145.)

[1] Iowa AH Leaflet 140.

panies of better methods of removing the oil, such complaints have almost disappeared. Formerly there was much discussion regarding the relative merits of hydraulic, expeller, and solvent meals, and the superior value claimed for the toasted meals. Extensive experiments carried out at several of the Corn Belt stations have disclosed no important advantage of one over the others for finishing cattle. Apparently feeders should follow the practice of buying soybean oil meal on the basis of its guaranteed protein content, regardless of the method by which it was manufactured. (See Table 144.)

Soybean oil meal, like linseed and cottonseed meal, is made and sold as cake, pellets, or finely ground meal. As a rule the meal is

Table 144

EFFECT OF THE METHOD OF PROCESSING UPON THE VALUE OF SOYBEAN OIL MEAL FOR FINISHING CATTLE

	Illinois Mimeo. Report, Oct 20, 1933				Iowa AH Leaflets 158 and 159		Illinois Mimeo. Reports, 1935, 1936, 1938	
	Calves				Yearling Steers (Average 2 trials)		Steer Calves (Average 3 trials)	
	Hydraulic		Expeller					
	Max. Temp., F.		Max. Temp., F.					
Protein Concentrate Fed	180°	220°	200°	300°	Expeller	Solvent	Old Process*	New Process
Av. daily gain, lb.	1.99	1.89	1.86	1.90	1.78	1.87	2.06	2.00
Av. daily ration								
Shelled corn	9 2	8.8	8 4	8 6	10.5	10 6	10.2	10.1
Protein concentrate	1.4	1.3	1.2	1.3	1.3	1.3	1.5	1.4
Corn silage	8 1	8.1	8.1	8.1	12.0	12.0	4.9	4 9
Legume hay	2 0	2.0	2 0	2 0	1.6	1.6	2.7	2.7
Feed per cwt. gain								
Shelled corn	461	468	451	454	594	564	493	504
Protein concentrate	68	69	67	67	76	68	72	73
Corn silage	406	427	435	425	677	642	226†	231†
Legume hay	100	106	108	105	91	86	134†	137†
Selling price per cwt.	.		. .	.	$11.15	$11.30	$10.43	$10 42
Net return over feed costs	.			....	$ 7.11	$11.29	$15 38	$14.52

* The old process meal was made by the *hydraulic* method in 2 trials and by the *expeller* method in the third trial.

† Corn silage fed in 2 of the 3 trials In the third trial alfalfa was the only roughage fed.

Table 145

COMPARATIVE VALUE OF SOYBEANS, SOYBEAN OIL MEAL, AND COTTONSEED MEAL FOR FINISHING CATTLE

	Illinois Experiment Station Mimeo. Report, 1926–1927				Iowa AH Leaflets 158 and 159		Indiana Bull. 330, 1929	
	1 Trial with Calves				2 Trials with Yearlings		2 Trials with 2-Year-Old Steers	
	Ground Soybeans	Whole Soybeans	Soybean Oil Meal	Cottonseed Meal	Soybean Oil Meal	Cottonseed Meal	Whole Soybeans	Cottonseed Meal
Av. daily gains, lb.	2.11	2.26	2.36	2.35	1.78	1.85	2.51	2.20
Av. daily ration								
Shelled corn	8.5	9.0	9.1	10.1	11.0	11.30	12.4	12.3
Protein concentrate	1.3	1.3	1.4	1.5	1.3	1.5	2.3	2.3
Corn silage	8.1	8.1	8.1	8.1	12.0	12.0	24.1	26.2
Legume hay	2.0	2.0	2.0	2.0	1.6	1.6	3.5	3.7
Feed per cwt. gain								
Shelled corn	401	395	387	428	594	611	492	538
Protein concentrate	60	59	57	63	76	78	91	100
Corn silage	385	358	344	343	677	649	961	1,146
Legume hay	95	88	85	85	92	87	139	162
Selling price per cwt.	$10.85	$11.15	$11.60	$11.85	$11.15	$11.15	$9.35	$8.95
Gain of hogs per steer, lb.	39	28	24	38	.		67	50

cheaper and more readily available because it is more easily made and is in great demand for feeding swine, poultry, and dairy cattle. However, pea-size cake or pellets are much better for feeding with shelled corn, and pellets or cake 1 to 2 inches in size are recommended for use in the range area where *the feed is frequently scattered on the* ground.

Although whole soybeans are noticeably inferior to soybean meal, they make a fairly satisfactory supplement when carefully fed in moderate quantities. They appear to be more satisfactory for older cattle than for calves, probably because older cattle are fed for a shorter time and are given more roughage. There is some evidence that the feeding of corn silage with whole soybeans or with soybean oil meal tends to overcome the laxative effects sometimes caused by these feeds. For example, steer calves fed 2.5 pounds of soybean oil meal per head daily at the Iowa station went off feed and scoured badly after the silage was reduced by one-half at the end of 210 days of feeding.[1] This theory may explain the unusually good showing made by 2-year-old steers fed whole soybeans in the Indiana experiments, since the grain rations were to some extent restricted and relatively large amounts of silage were fed. (See Table 145.)

[1] Iowa AH Leaflet 140.

Table 145

COMPARATIVE VALUE OF SOYBEANS, SOYBEAN OIL MEAL, AND COTTONSEED MEAL FOR FINISHING CATTLE

	Illinois Experiment Station Mimeo. Report, 1926–1927				Iowa AH Leaflets 158 and 159		Indiana Bull. 330, 1929	
	1 Trial with Calves				2 Trials with Yearlings		2 Trials with 2-Year-Old Steers	
	Ground Soybeans	Whole Soybeans	Soybean Oil Meal	Cottonseed Meal	Soybean Oil Meal	Cottonseed Meal	Whole Soybeans	Cottonseed Meal
Av. daily gains, lb	2.11	2.26	2.36	2.35	1.78	1.85	2.51	2.29
Av. daily ration								
Shelled corn	8.5	9.0	9.1	10.1	11.0	11.30	12.4	12.3
Protein concentrate	1.3	1.3	1.4	1.5	1.3	1.5	2.3	2.3
Corn silage	8.1	8.1	8.1	8.1	12.0	12.0	24.1	26.2
Legume hay	2.0	2.0	2.0	2.0	1.6	1.6	3.5	3.7
Feed per cwt. gain								
Shelled corn	401	395	387	428	594	611	492	538
Protein concentrate	60	59	57	63	76	78	91	100
Corn silage	385	358	344	343	677	649	961	1,146
Legume hay	95	88	85	85	92	87	139	162
Selling price per cwt.	$10.85	$11.15	$11.60	$11.85	$11.15	$11.15	$9.35	$8.95
Gain of hogs per steer, lb.	30	28	24	38			67	50

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Although whole soybeans are noticeably inferior to soybean meal, they make a fairly satisfactory supplement when carefully fed in moderate quantities. They appear to be more satisfactory for older cattle than for calves, probably because older cattle are fed for a shorter time and are given more roughage. There is some evidence that the feeding of corn silage with whole soybeans or with soybean oil meal tends to overcome the laxative effects sometimes caused by these feeds. For example, steer calves fed 2.5 pounds of soybean oil meal per head daily at the Iowa station went off feed and scoured badly after the silage was reduced by one-half at the end of 210 days of feeding.[1] This theory may explain the unusually good showing made by 2-year-old steers fed whole soybeans in the Indiana experiments, since the grain rations were to some extent restricted and relatively large amounts of silage were fed. (See *Table 145.*)

[1] Iowa AH Leaflet 140.

to be used by the cattle feeders throughout the country and by the ranchers of the Western Range.

PROTEIN CONTENT. Although cotton is not a legume its seeds contain a relatively large amount of protein, normally about 20 per cent. With the removal of the hulls and the extraction of the oil, the protein content of the remaining meal is approximately double that of the whole seed. Although the percentage of protein varies somewhat according to the completeness with which the hulls are removed, the better grades of cottonseed meal stand at or near the top of the list of high-protein feeding stuffs fed to cattle. Cottonseed is now processed mainly by the solvent process, as are soybeans, although the changeover is taking place more slowly in the cottonseed processing industry. Some mills, however, still use the hydraulic and expeller processes, and the protein and oil content of cottonseed meal usually vary slightly depending upon the method used. Recent experimental work indicates that the solvent method of processing cottonseed being used today results in meals which are slightly lower in feeding value than the expeller meals. This result is undoubtedly due to the lower fat and higher fiber content of the solvent meals. Two Oklahoma tests[2] showed a $7.62 per head larger return from the steers fed hydraulic-processed meal than from those fed solvent meals.

PHYSICAL PROPERTIES. Cottonseed meal should be of a rather light yellowish-brown color and have a pleasant nut-like odor. A dark, dull color signifies a lower-grade product and is due to the presence of an abnormal number of hull particles. Although the finely ground "meal" is the product commonly used in this country, it is by no means the only form in which the material is sold. During recent years more and more cottonseed meal has been "pelleted" by forcing the finely ground meal through steel dies of varying sizes. The resulting pellets vary from ⅛ to ¾ inches in diameter and from ¼ to 1½ inches in length. The small pellets are satisfactory for feeding with shelled or coarsely ground corn. The larger pellets, commonly referred to today as "range cubes," are popular in the range area where cake or cubes are frequently fed to cattle during the winter by scattering them upon the dry ground. Often the cottonseed meal is mixed with 10 to 20 per cent of its weight of ground alfalfa to obtain a cake that is a valuable source of carotene. Molasses is often added to the mixture in amounts sufficient to produce a pellet that does not crumble during shipment and handling.

WHOLE-PRESSED COTTONSEED MEAL. Not all cottonseeds are hulled before the oil is extracted. A relatively small percentage goes directly

[2] Oklahoma Experimental Station Bulletin B-428, 1954

Some difference of opinion exists as to the advisability of grinding the beans for cattle. A few experiments indicate that grinding is not only unnecessary but even undesirable, at least for calves. Calves fed ground beans by the Illinois station had poorer appetites, made smaller gains, scoured more frequently, and showed a much greater tendency to go off feed than calves fed whole beans. Grinding may possibly cause the beans to be more subject to oxidation with resulting rancidity.

High-protein content soybean oil meal (50 per cent) is assuming considerable importance and is quite likely to increase in this respect. In the usual solvent processing methods soybean hulls are virtually all removed, leaving a meal which contains slightly upwards of 50 per cent protein. In the past the hulls were added back to the meal so that the protein content was reduced close to whatever the guarantee called for, usually about 44 per cent. The swine, and especially the poultry feed industries are willing to pay a premium for the lower-fiber-content 50 per cent protein meals because of their higher energy content. It is because of this demand from the mixed-feed industry for the 50 per cent meal, and also because soybean processors have developed a fairly good market for their hulls for industrial uses, that many processors have discontinued production of the once customary 42 to 44 per cent concentrate. The relative feeding value of the higher protein concentrates has not been thoroughly tested with cattle, but it would seem to be a safe assumption that these concentrates should be bought on a cost per unit of protein basis, as is the case with other protein concentrates. The lower fiber content would not assume the same importance in cattle feeding as it does in feeding poultry and swine because cattle are normally fed higher fiber content rations, and the slightly reduced fiber content of the total ration resulting from the use of a 50 per cent protein content concentrate would be of little importance.

Cottonseed and Cottonseed-Meal. Strange as it may seem, the diversified livestock farming of the northern states depends in considerable measure for its success upon the Cotton Belt. Except for the large surplus of cottonseed products of the southern and western states, many cattle feeders would experience considerable difficulty in supplying balanced rations for their cattle. If, as now seems probable, southern farmers continue to engage more extensively in livestock production, putting more and more of their present cotton acreage into corn, hay, and pasture crops, a considerable proportion of the reduced production of cottonseed will find a ready market in the South. Until that time, however, there is a large amount of meal and cake

is only a little above that of corn, so that feeders are tempted to use it much more liberally than they do when normal prices prevail. In considering *cottonseed meal as an energy source it should be remembered* that corn contains about 80 per cent of total digestible nutrients, whereas solvent process cottonseed meal contains only 65 per cent. One should therefore not expect to obtain much advantage from substituting cottonseed meal for corn at levels above that needed for protein supplementation purposes.

COTTONSEED MEAL POISONING. In the past, cattle that were fed cottonseed meal over an extended period sometimes became unthrifty

Table 146

EFFECT OF ADDING A CRUDE CAROTENE CONCENTRATE TO THE COTTONSEED MEAL FED TO FEEDER STEER CALVES*

(Three Trials, 1948–51—174 Days on Test)

	Lot 1 *Cottonseed* Cake	Lot 2 *Cottonseed Meal* Pellets + Carotene†
Total number of steers	29‡	30
Average weights, lb.		
Initial	496	495
Final	870	868
Average daily gain	2.15	2.14
Average daily ration, lb.		
Ground shelled corn	11.12	11.43
Protein supplement	1.50	1.50
Alfalfa hay	1.00	1.00
Sorghum silage	6 59	6.58
Salt	0.04	0.04
1–1–1 mineral mixture	0 04	0 04
Feed cost per cwt. gain, $	19 22	20 63
Financial results, $		
Selling price per cwt.	30 08	29 92
Total value per steer (3% shrink)	253.88	251.93
Initial cost per steer	145.38	145.08
Feed cost per steer	71.89	74 77
Total cost per steer	217.27	219.85
Return per steer	36 61	32.08
Av. U.S. carcass grade§	Av. choice	Av. choice

* Oklahoma Bulletin No. B-428, 1954

† Crude carotene concentrate was added to the cottonseed meal to supply 13.7 mg of carotene per lb. of supplement fed.

‡ One steer was removed in the second trial and not included in these data.

§ Carcass grades obtained only in the third trial

from the gin into large hydraulic presses where as much of the oil is extracted as possible. The residue, consisting of both hulls and kernels, is known as "whole-pressed" cottonseed cake. The high percentage of fiber resulting from the presence of the hulls makes the feeding value of this type of cake relatively low. As a rule it is sold in either the nut or pea form, although it may be ground into a meal.

COTTONSEED FEEDS. Owing to the high prices that have prevailed for high-grade cottonseed meal, some cottonseed products have been manufactured and offered for sale that have a relatively low feeding value. Because of the considerable amount of ground hulls they contain, such material can be sold for a much lower price than first quality cottonseed meal. Cattle feeders should not be misled into thinking that these "cottonseed feeds" are equal to the higher priced meal in feeding value. When the cost per pound of digestible protein is taken into consideration, the higher-grade product usually proves to be the more economical.

COTTONSEED MEAL AS A SUBSTITUTE FOR CORN. In the South and West where cottonseed meal is abundant and relatively cheap, it is frequently fed in large amounts as a substitute for corn in finishing cattle for market. Occasionally its cost per pound in the Corn Belt

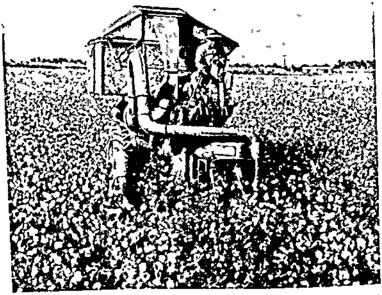

FIG. 75. The cotton fields of the South and West constitute the second most important source of protein concentrate for cattle (soybeans being first). (International Harvester Company, Chicago, Illinois.)

produced in the United States is made by first crushing and then heating the flaxseed, after which the oil is extracted by means of hydraulic or expeller presses. Such meal is called "old process" meal. In contrast with this is the so-called "new process" meal from which the oil has been removed from the crushed seeds by solvent extraction.

The new process removes a greater percentage of the oil than the old process and the protein content of the new process meal is therefore approximately 3 per cent higher. However, the protein of the old process meal is somewhat more digestible, so that there is only a little difference in digestible protein between the two forms. Most feeders prefer linseed meal made by the old process because of its higher percentage of oil. This oil is believed by some feeders to have a high feeding value and to produce a beneficial effect upon the general health of the animal through a proper regulation of the bowels. However, feeding tests, such as those shown in Table 147, designed to compare meals made by the two processes, have disclosed no significant advantage of one over the other for finishing cattle.

Many feeders, especially those feeding for the higher market grades, feed linseed meal in the belief that sleeker haircoats with resultant higher selling prices are obtained. The alleged effective agent, mucin, is a gelatinous material, covering the outer hull of the flaxseed, which is removed from the hull in extraction. Whereas it is true that linseed meal contains mucin, experimental work done at the Iowa Experiment Station did not satisfactorily prove that either haircoat or carcass quality is affected by the use of mucin.

Table 147

Comparison of Old Process and New Process Linseed Meal for Finishing Cattle

	Colorado Mimeo. Report, 1948–1949		Iowa AH Leaflet 158, 1939–1940		
	Expeller Linseed Meal	Solvent Linseed Meal	Hydraulic Linseed Meal	Expeller Linseed Meal	Solvent Linseed Meal
Av. initial weight, lb.	844	848	720	721	723
Av. daily gain	2.37	2.35	2.09	2.14	1.98
Av. daily ration					
Grain	17.7	17.7	12.2	12.8	11.9
Protein concentrate	0.9	0.9	1.5	1.4	1.5
Corn silage	..	.	12.6	12.6	12.6
Legume hay	4.9	4.9	1.7	1.7	1.7
Feed cost per cwt. gain	$22.81	$22.99	$8.65	$8.54	$8.93
Selling price per cwt.	21.25	21.25	10.10	10.30	10.15
Dressing percentage	61.8%	62.9%	. . .		....

in appearance, showing harsh coats and inflamed eyes. Some animals even, in time, became blind. Such trouble formerly was rather common in the South, where large quantities of cottonseed meal were often fed along with cottonseed hulls or other low-grade roughages for rather long periods. Reports of such conditions caused some feeders to believe that cottonseed meal was not a safe feed for cattle which were to be fed for several months. It has now been established that a number of cases of so-called "cottonseed meal poisoning" were due to a deficiency of vitamin A. The characteristic symptoms of the disease have been produced by feeding rations low in this vitamin and they have disappeared entirely when an adequate amount of vitamin A or carotene was provided.

If legume hay of good quality, or silage, is included in the ration containing cottonseed meal as a protein supplement, it is doubtful if carotene or vitamin A supplementation is essential. This is especially true if the feeder cattle are not from an extremely droughty area. Table 146 shows the results of a 3-year study dealing with this subject.

The so-called cottonseed meal poisoning referred to previously is not to be confused with the gossypol poisoning produced by feeding large amounts of cottonseed meal to swine. Evidently this chemical, which is present in cottonseed meal processed according to standard procedures, does not affect cattle.

Linseed Meal. Linseed meal, linseed oil meal, or simply oil meal, as it is sometimes called, is the product that results from the extraction of oil from flaxseed. Flax, like cotton, is not a legume but produces a seed containing a high percentage of protein and oil. When the oil is extracted the percentage of protein in the residue is further increased. The average protein content of flaxseed is approximately 17 per cent, whereas that of the meal is slightly over twice this amount.

Flax is grown on a much smaller scale than cotton or soybeans in the United States. Altogether only 600 to 800 thousand tons of flaxseed are produced annually, over half of which are grown in Minnesota and North Dakota. This amount is not sufficient to meet the demand for linseed oil and an additional 200 to 400 thousand tons of flaxseed are imported, principally from Argentina. Previous to World War II nearly half of the linseed cake produced in the United States was exported to Europe, but since the war the amount exported has been negligible.

All flaxseed except that needed for planting is sold to processing plants where the oil is extracted. Almost none of the whole seed is used for feeding purposes.

Old and New Process Linseed Meal. Much of the linseed meal

Table 148

COMPARISON OF LINSEED MEAL AND COTTONSEED MEAL FOR FEEDER CATTLE

	Iowa Mimeo Reports AH Leaflets D-86, 158, 159				Missouri Bull. 150		Ohio Bimonthly Bull. 140	
	2-Year-Old Steers		Yearling Steers (Av. 2 trials)		2-Year-Old Steers (No Corn Ration)		Calves	
	Linseed Meal	Cotton-seed Meal	Linseed Meal	Cotton-seed Meal	Linseed Meal	Cotton-seed Meal	Linseed Meal	Cotton-seed Meal
Days fed	120	120	225	225	132	132	119	119
Av. initial wt., lb.	1080	1080	689	689	921	926	405	404
Av. final wt.	1385	1318	1149	1109	1230	1212	652	633
Av. daily gain	2.56	2.05	2.06	1.85	2.42	2.18	2.07	1.92
Av. daily ration								
Shelled corn	22.0	19.4	12.6	11.3	..	.	6.6	6.6
Protein concentrate	1.5	1.5	1.6	1.5	4.7	4.7	2.0	2.0
Corn silage	..	..	12.1	12.1	43.5	42.1	9.1	8.7
Legume hay	7.1	8.1	1.6	1.6	4.9	4.3	1.9*	1.8*
Feed per cwt. gain								
Shelled corn	861	946	615	611	..	..	322	347
Prot. conc.	59	73	78	79	195	210	97	104
Corn silage	..	..	586	649	1797	1921	441	453
Legume hay	278	396	79	87	203	195	91*	96*
Feed cost per cwt. gain	$13.44	$15.71	$9.14	$9.29	$10.08	$9.97	$9.60	$9.89
Selling price per cwt.	$10.00	$9.75	$11.45	$11.20	$10.85	$10.75	$12.85	$12.85
Net return over feed costs	5.48	−0.97	11.47	7.03	19.07	14.63	7.63	6.23

* Mixed hay.

has a protein content of approximately 40 per cent. Both these feeds are used more extensively for dairy cattle than for beef cattle.

Gluten feed is decidedly inferior to the oil-seed meals in finishing rations when used as the sole protein supplement, but it can be successfully substituted for up to one-half of the oil-seed meals. Gluten meal, on the other hand, is almost equal to the oil-seed meals as shown in Table 149 but, as gluten feed, the best use of gluten meal is as a partial substitute for the more commonly used oil-seed meals. Equal parts of gluten meal and linseed meal gave results approximately equal to linseed meal alone in finishing calves at the Kansas station (See Table 151.) Since gluten feed contains less protein than cotton-

Physical Properties. In appearance, linseed meal is grayish brown in color and is somewhat coarser in texture than cottonseed meal. Like cottonseed and soybean products it is made in various degrees of fineness, varying from finely ground meal to pellets. The pea-size pellet has become increasingly popular and has largely displaced the finely ground product in many sections of the country.

Linseed meal, because of its marked adhesive qualities when under pressure, is especially easy to pellet. Consequently, more of it is processed and sold in this form than is the case with cottonseed meal. Almost all of the linseed meal exported is in the form of cake.

Linseed Meal and Cottonseed Meal Compared. Theoretically, cottonseed meal is somewhat more valuable than linseed meal, since it is 5 to 10 per cent higher in protein. Most practical feeders, however, prefer the linseed meal because of its supposed beneficial effect on the general health of the cattle. This effect is probably brought about by the tendency of the linseed meal to produce a slightly laxative effect. Cottonseed meal, on the other hand, has a tendency to make cattle somewhat constipated. For this reason it is often considered superior to linseed meal when used in connection with feeds that are themselves laxative, such as silage, alfalfa hay, or grass. In general, however, feeding experiments do not bear out this contention. Instead they show a distinct superiority for linseed over cottonseed meal under nearly all conditions.

A summary of all available experimental results of the comparative feeding value of these two protein supplements discloses that linseed meal is approximately 40 per cent more valuable than cottonseed meal when fed in a dry lot, and 20 per cent more valuable when fed on bluegrass pasture.[3] This wide difference in the money value per ton based upon profits actually returned is largely due to the difference in the price per hundredweight received for the finished cattle. When linseed meal can be purchased at only $10 to $15 a ton more than cottonseed meal, its use is recommended; otherwise cottonseed meal is likely to be more profitable for feeding for the open market.

Gluten Feed. Gluten feed is a by-product of corn and is produced in considerable quantities by corn wet millers. It consists of the outer layers of the corn kernel, which are separated from the starch particles in the wet milling processing of corn. Sometimes the outer hull is separated from the underlying gluten layer, which is then sold under the name "gluten meal."

Gluten feed contains about 25 per cent protein, whereas gluten meal

[3] C. C. Culbertson et al., *Proceedings of American Society of Animal Production*, 1923, p. 21.

Table 148

COMPARISON OF LINSEED MEAL AND COTTONSEED MEAL FOR FEEDER CATTLE

	Iowa Mimeo. Reports AH Leaflets D-86, 158, 159				Missouri Bull. 150		Ohio Bimonthly Bull. 140	
	2-Year-Old Steers		Yearling Steers (Av. 2 trials)		2-Year-Old Steers (No Corn Ration)		Calves	
	Linseed Meal	Cottonseed Meal	Linseed Meal	Cottonseed Meal	Linseed Meal	Cottonseed Meal	Linseed Meal	Cottonseed Meal
Days fed	120	120	225	225	132	132	119	119
Av. initial wt., lb.	1080	1080	689	689	921	926	405	404
Av. final wt.	1385	1318	1149	1109	1239	1212	652	633
Av. daily gain	2.56	2.05	2.06	1.85	2.42	2.18	2.07	1.92
Av. daily ration								
Shelled corn	22.0	19.4	12.6	11.3	..		6.6	6.6
Protein concentrate	1.5	1.5	1.6	1.5	4.7	4.7	2.0	2.0
Corn silage	..	..	12.1	12.1	43.5	42.1	9.1	8.7
Legume hay	7.1	8.1	1.6	1.6	4.9	4.3	1.9*	1.6*
Feed per cwt. gain								
Shelled corn	861	946	615	611	.	..	322	347
Prot. conc.	59	73	78	79	195	219	97	104
Corn silage	..	.	586	649	1797	1921	441	453
Legume hay	278	396	79	87	203	195	91*	96*
Feed cost per cwt. gain	$13.44	$15.71	$9.14	$9.29	$10.08	$10.97	$9.60	$9.89
Selling price per cwt.	$10.00	$9.75	$11.45	$11.20	$10.85	$10.75	$12.85	$12.85
Net return over feed costs	5.48	−0.97	11.47	7.03	19.07	14.63	7.53	6.23

* Mixed hay.

has a protein content of approximately 40 per cent. Both these feeds are used more extensively for dairy cattle than for beef cattle.

Gluten feed is decidedly inferior to the oilseed meals in finishing rations when used as the sole protein supplement, but it can be successfully substituted for up to one-half of the oilseed meals. Gluten meal, on the other hand, is almost equal to the oilseed meals as shown in Table 149 but, as gluten feed, the best use of gluten meal is as a partial substitute for the more commonly used oilseed meals. Equal parts of gluten meal and linseed meal gave results approximately equal to linseed meal alone in finishing calves at the Kansas station (See Table 151.) Since gluten feed contains less protein than cotton-

Table 149

VALUE OF CORN GLUTEN MEAL FOR FEEDER CATTLE*
(Two-Year-Old Steers Fed in Dry Lot)

Supplement	None	Linseed Meal	Cottonseed Meal	Gluten Meal
Daily gain, lb.	1.77	1.94	1.88	1.83
Feed per lb. gain, lb.				
Concentrates	10.47	9.56	10.03	10.49
Roughage	6 63	5.29	5.89	5.95
Pork per steer	113.9	124.5	116.9	144.8

* Iowa Bulletin No. 79.

seed or linseed meal, it should be purchased at a correspondingly lower price per ton.

Wheat Bran. Large quantities of wheat bran are produced annually by the flour mills of North America. Although comparatively little of this material is used in the finishing of beef cattle, it occasionally happens that feed prices make it the cheapest source of protein available. Because of its bulk and high percentage of fiber, bran is not an especially good feed for cattle that are being finished for market. The rather pronounced laxative effect that it produces, when fed in large quantities, is also unfavorable to its extensive use by cattle feeders. On the other hand, these very qualities commend it as a feed for breeding animals and for young cattle intended for the breeding herd. When mixed with the common farm-grown grains, wheat bran adds bulk and lightness to the ration as well as generous quantities of phosphorus, an element greatly needed by pregnant cows and young, growing bulls and heifers.

Bran differs from most of the nitrogenous concentrates already discussed in that it has considerably less protein. For this reason it must be fed much more liberally than the oilseed meals to add the same amount of protein to the ration. As a rule it is not advisable to attempt to add as much protein through bran as would be possible through the oilseed meals, since the amount of bran required would render the ration too bulky and too laxative. Results of feeding trials in which bran was used are shown in Table 150. Bran contains somewhat more carbohydrates than the oilseed meals, a fact that should be considered in determining the relative economy of these feeds. For practical purposes, 2 pounds of bran may be considered as having the same feeding value as 1 pound of any of the oilseed meals.

The most extensive use of bran for finishing cattle is made in the highly specialized cattle feeding sections of the eastern states in which not only protein concentrates but also carbonaceous feeds must be purchased in rather large quantities. Under these conditions a feed such as bran, which carries both protein and carbohydrates, finds considerably more favor than it does in the Corn Belt where an adequate supply of carbohydrates is available in farm-grown grain.

Brewers' and Distillers' Grains. *In the pre-Prohibition era the* expended grains of the liquor industry were commonly fed in the form of wet mashes and "slops" to cattle located near the distilleries. Now, however, they are usually dried, bagged, and sold as brewers' and distillers' dried grains. Brewers' grains, *made principally from barley*, contain about twice as much protein and fiber but only 90 per cent as much total digestible nutrients as the original grain. Because of their bulky nature they are seldom fed to beef cattle but are used principally in the manufacture of mixed feeds for dairy cows. In a test made at the Illinois station, brewers' dried grains proved to be a much less valuable source of protein for beef calves than soybean oil meal. (See Table 151.)

Distillers' dried grains are obtained from the use of corn, rye, wheat, or grain sorghum in the manufacture of beverage and industrial alcohol. Those resulting from corn and wheat are much higher in protein and

Table 150

Comparative Value of Wheat Bran and Cottonseed Products for Steers*

	Full Corn Ration 140 Days		Two-thirds Full Corn Ration 112 Days	
Supplement Fed	Wheat Bran	Cottonseed Meal	Wheat Bran	Cold Pressed Cottonseed Cake
Approx. ratio of corn to supplement	78:22	90:10	58:42	82:18
Initial weight—lb.	973	988	778	743
Average daily gain	1.76	2.11	1.55	1.59
Feed per lb. gain:				
Concentrates	14.19	10.83	7.19	6.93
Prairie hay	.		5.14	4.94
Corn stover	5.06	4.21		
Value of pork produced per cwt. gain on steers	$2.30	$1.68		

* Nebraska Bulletins Nos. 116 and 132.

Table 151

THE VALUE OF BREWERS' AND DISTILLERS' DRIED GRAINS FOR FEEDER CATTLE

	Brewers' Grains		Distillers' Dried Grains and Solubles				
	Calves, Illinois Mimeo. Report, 1936		2-Year-Old Steers, Iowa AH Leaflet 153		Heavy Calves Nebraska Cattle Progress Report 194		
	Soybean Oil Meal	Brewers' Grains (Barley)	Linseed Meal	Distillers' Grains (Corn)	Linseed Pellets	Distillers' Grains with Solubles	No Protein Concentrate
Protein content of supplement	44.7%	31.5%	....	....	34 8%	25.9%	...
Wt. of supplement per bushel, lb.	31	18	....	..	...	....	...
Av. daily gain	2.06	1.88	2.36	2.21	1.88	1.69	1.35
Av. daily ration							
Shelled corn	9.2	7.2	10.5	9.2	12.7	10.4	11.3
Protein concentrate	1.3	3 0	1.5	2 0	1.7	2.6	...
Corn silage	7.4	7.4	35 5	32.1	.		...
Legume hay	2.0	2.0	1.2	1.4	5 7*	5 1*	6.0*
Selling price per cwt.	$8.65	$8.50	$14 00	$14.50	$26 50	$25.50	Not sold†
Hog gains per steer, lb.	25	18	66	57	...	...	...

* *Prairie hay fed in Nebraska experiment.*

† The steers in the lot fed no protein supplement were not fat enough to be sold for slaughter.

total digestible nutrients than those made from rye or the grain sorghums; consequently they are much more valuable per ton as a feed for livestock.

In the disposal of the distillery "slop" after the alcohol has been distilled off, the solid particles of grain are screened out and dried to make distillers' dried grains. The liquid portion, which contains the water-soluble nutrients and very fine particles of grain, is condensed by evaporation and dried to form distillers' dried solubles. This product has received much publicity because it is an excellent source of the B vitamins, which are so important in the feeding of poultry and swine. Since cattle have little need for these vitamins, distillers' dried solubles are seldom fed to beef cattle except when mixed with distillers' dried grains. When so added the mixture is called distillers' dark grains or distillers' dried grains with solubles.

Distillers' dried grains may be regarded as a satisfactory substitute for the oilseed meals in the ration of finishing cattle if sufficiently large amounts are fed to furnish the proper amount of protein. Feeding tests indicate that 1 ton of distillers' dried grains replaces about 1,500 pounds of soybean or cottonseed meal and 10 bushels of shelled corn

if fed at the rate of 2 to 3 pounds per head daily. The feeding of larger amounts usually is not economical unless the dried grains are no higher in price per pound than shelled corn.

Urea and Other Non-protein Nitrogenous Materials. As has been previously discussed in Chapter 8, rumen bacteria can utilize nitrogen from non-feed sources such as urea and ammonia in the synthesis of bacterial protein which, in turn, can be used by the ruminant in meeting its own protein requirement. The non-protein nitrogenous substances mentioned are produced synthetically in larger quantities each year and they are now in a favorable competitive position, pricewise, with the protein concentrates.

Because of its hydroscopic nature, urea is prepared for use as feed by the addition of substances that prevent caking in storage. Urea contains 46.7 per cent nitrogen, but after dilution with these substances, the nitrogen in feed urea is reduced to approximately 42 per cent. Since the crude protein content of a feed is determined by multiplying the percentage nitrogen content by 6.25, the crude protein content of urea feed is 262 per cent—hence the trade name "262." Such an expression, of course, must be interpreted to mean that a given weight of "262" contains as much nitrogen as a quantity of pure protein that is 2.62 times as heavy. Since cottonseed meal is only 43 per cent protein, it would require approximately 6.1 pounds of 43 per cent cottonseed meal to furnish as much nitrogen as is present in 1 pound of urea feed. Consequently, if the nitrogen of urea feed were utilized by cattle to the same extent as the nitrogen in cottonseed meal, 1 pound of urea feed would replace 6.1 pounds of cottonseed meal as far as the protein of the ration is concerned.

When administered to cattle in solution in the form of a drench, urea is highly toxic; even as little as ¼ pound of urea administered to an adult cow directly into the paunch causes death in 40 to 90 minutes. The toxicity is believed to be the result of rapid conversion of urea nitrogen to ammonium carbamate which is absorbed directly into the bloodstream from the paunch. However, if urea is fed to cattle by thoroughly mixing it with the grain ration or with silage, no ill effects are noted.

Early studies of urea as a possible protein substitute indicated that it would be utilized to a higher degree if it were fed with some carbohydrate, such as molasses, that would constitute a source of energy for the rumen bacteria. However, feeding trials at the Oklahoma and Iowa stations indicate that the addition of molasses is of no value, at least for cattle that are fed large quantities of carbohydrates in the form of farm grains. (See Table 152.) It is possible that molasses

Table 152

Value of Urea as a Protein Substitute for Feeder Cattle

	Oklahoma* Calves, 167 Days Average 2 Trials			Iowa† Yearlings, 175 Days Average 2 Trials			
	C.S M.	¼ Urea N ¾ C.S.M. N	½ Urea N ½ C.S M. N	Prot. Conc.	½ Urea N ½ P.C. N	Urea	Urea Fed with 1 lb. Molasses
Av. daily gain, lb.	2 14	2.11	2.17	2.26	2.32	2 24	2.22
Protein supplement.	1 5	1.5	1.5	1.25	0.75	0 20	0 20
Urea intake daily[a]	.	(.06)	(.12)	....	(.10)	(.20)	(.20)
Protein content of sup., %	41.8	46 7	47.3	....	....	....	....
Feed per cwt. gain							
Shelled corn, lb..	528	511	518	662	681	701	686
Protein sup[a]	71	71	69	61	40	9	9
Molasses	.	. .	...	....	. ..	....	45
Legume hay	47	49	46	214	213	226	217
Silage	445	457	436	....	....	....	45
Feed cost per cwt. gain	$25 92	$26 30	$25 53	$21.92	$21.06	$20.13	$21 39
Selling price per cwt.	26 75	26 125	26.75	33 00	33.125	33.00	33.00
Cost of prot sup. per ton	92 50	98 05	98.05	....	....	....	....

* Oklahoma Miscellaneous Publications 11 and 13.
† Iowa Mimeo. AH Leaflets 176 and 179.
[a] Urea included in weight of protein supplement.

may favor the utilization of urea by stocker cattle fed principally low-grade roughages such as ground corn stover and corn cobs, although here the principal value of molasses may be as an appetizer.

Urea is now recognized as a satisfactory ingredient of commercial protein supplements manufactured for cattle or sheep. However, its high nitrogen content makes it possible for mixed-feed companies to put out a feed with a "crude protein" content of 20 to 30 per cent which would be of low feeding value because of the small amounts of total digestible nutrients present. Consequently, in buying a commercial protein supplement of which urea is one of the constituents, care should be taken to determine both the percentage of the total nitrogen which is in the form of urea nitrogen, and the nature of the other ingredients of the mixture. If the other ingredients are high-quality ingredients such as cottonseed meal, hominy feed, and alfalfa meal,

urea nitrogen may well constitute 25 or even 50 per cent of the total nitrogen of the supplement. In feeding tests at the Oklahoma station such supplements gave as good results as cottonseed meal. (See Table 152.) Pellets in which more than 50 per cent of the nitrogen is from urea are likely to be unpalatable, and not enough is eaten to furnish the protein required. Pellets containing 4 per cent urea by weight are not unpalatable, as indicated by an average daily consumption of 10 pounds of such pellets when full-fed to steer calves for 14 days at the Oklahoma station. Beef cows fed 6 pounds of these pellets every other day during the winter calved normally and showed no toxic effects from the urea.[4]

The following statements summarize the problems involved in the use of urea and other non-protein nitrogenous materials:

1. Do not use urea at levels which supply over ⅓ of the total nitrogen or protein equivalent in finishing rations or over ¼ in growing rations.
2. Do not use over 1 per cent of urea, by weight, in complete mixed rations or over 5 per cent of urea, by weight, in protein concentrates.
3. Add 6 pounds of a high-energy concentrate such as corn, molasses, or sorghum with each pound of urea to replace 7 pounds of the usual high-protein concentrates such as soybean oil meal.
4. In supplements or in complete rations, urea should be thoroughly incorporated, preferably by means of a commercial type of mixer, to insure even distribution of the urea and to prevent it from settling out.
5. Additional minerals such as phosphorus and sulfur may be needed when larger quantities of urea are substituted for non-protein nitrogenous materials.
6. Study the feed tag which describes supplements containing urea and note especially the protein equivalent content derived from urea, and the fiber content, which is an indicator of the carbohydrate feed used to replace the weight of the usual protein concentrate.

There is no conclusive evidence that supplements which contain urea or similar nitrogenous materials are superior to those which do not. Therefore premiums should never be paid for such supplements. In fact, because these nitrogen sources are usually cheaper, the feeder should expect to buy them for less than would be paid for supplements containing oilseed meals alone as protein sources.

Biuret, a nitrogenous material produced by heating urea, is less toxic than urea and thus shows promise as a supplement. Ammonia, when mixed with molasses, apparently is satisfactory as a nitrogen

[4] Oklahoma Miscellaneous Publication 11.

source, but cases of supersensitivity in steers have been reported by Kansas and Oklahoma workers when such supplements were used. "Morea," a commercial product containing mainly urea, molasses, phosphoric acid, and ethanol or ethyl alcohol as a ready source of available energy, is being self-fed by some feeders with reported success, but experimental data are as yet inconclusive with respect to this supplement.

Alfalfa Meal. Dehydrated alfalfa meal made from leafy alfalfa cut in the pre-bloom stage of maturity contains from 18 to 22 per cent protein and may therefore be regarded as a protein concentrate. Because of the extreme degree of fineness to which the meal is usually ground it cannot easily be mixed with other feeds and is much too fine and dusty to be fed alone. However, when it is formed into pellets about the size of corn kernels it is an excellent protein supplement to feed with shelled or ground corn. Since its protein content is only about half that of cottonseed or soybean oil meal, approximately twice as much must be fed to supply a given amount of protein.

The demand for dehydrated alfalfa meal for poultry and swine feeding is so great that its price is usually too high to make it as economical a source of protein as linseed, cottonseed, or soybean oil meal for beef cattle, at least on the basis of protein content. However, feeding tests conducted at the Nebraska station suggest that dehydrated alfalfa may have a much higher feeding value than its protein content would indicate. (See Table 153.) Alfalfa meal made from green, leafy alfalfa which was dehydrated immediately after it was cut contains an abundance of carotene. However, there is very little likelihood that the yearling steers in the Nebraska experiment did not receive an ample amount of this vitamin from the ground ear corn and corn silage. Alfalfa meal makes a real contribution as a source of highly available phosphorus. It should be noted that dehydrated alfalfa pellets had a much lower feed replacement value in the second experiment with calves than in the first experiment with yearlings. The daily gains of all the yearling steers, except the check lot, were unusually large. Consequently the results obtained from feeding the alfalfa pellets to the yearling cattle may have been somewhat better than would be obtained under normal conditions.

Mixed Supplements. A question in the minds of most cattle feeders is that of the economy of commercial mixed supplements. Undoubtedly the fact that such supplements are a convenient way to supply all the needed additions to rations of grain and roughage has much to do with their increased use. As a rule they are pelleted and

Table 153

VALUE OF DEHYDRATED ALFALFA PELLETS AS A PROTEIN CONCENTRATE FOR BEEF CATTLE

	For Finishing Yearling Steers					Finishing Steer Calves		
	Nebraska Cattle Progress Report 190					Nebraska Cattle Progress Report 194		
	1.5 lb. S.B.O.M.	1 lb. S.B.O.M. 1 lb Dehy. Alfalfa Meal	0.5 lb. S.B.O.M. 2 lb. Dehy. Alfalfa Meal	3 lb. Dehy. Alfalfa Meal	1.5 lb. Dehy. Alfalfa Meal	Linseed Pellets	Dehy. Alfalfa Pellets	No Prot. Conc.
Av. daily gain, lb.	2.32	2.52	2.62	2.71	2.47	1.88	1.98	1.35
Av. daily ration								
Ground ear corn	17.6	18.2	17.8	18.4	18.7			
Shelled corn	.					12.7	11.8	11.3
Protein conc.	1.5	2.0	2.5	3.0	1.5	1.7	3.3	
Corn silage	11.3	11.8	11.6	11.9	11.5			
Prairie hay	...	..			.	5.7	5.0	6.0
Feed per cwt. gain								
Corn	756	720	678	677	756	673	596	838
Protein conc.	64	79	95	110	61	91	166	..
Corn silage	487	466	442	438	465	306	254	441
Prairie hay	....	.						.
Dressing percentage	61.6	63.7	60.8	62.5	59.8	59.6	59.4	*

* This lot was not fat enough to slaughter.

bagged in convenient 50-pound bags, or delivered in bulk with special discounts. The use of the protein supplement as the carrier for stilbestrol, antibiotics, vitamin A, or trace minerals, all of which may be desirable ingredients of the ration under certain conditions, makes this method of feeding the supplements very popular.

In addition to the above built-in conveniences in commercial mixed supplements, the claim is usually made that the mixture or variety of sources of protein improves the quality of the supplement. It is sometimes further claimed that the 12 or 18 per cent protein present in a mixed feed is in reality more efficient than the much larger amount of protein in the oilseed meals fed alone, owing to the lack of certain essential amino acids in the ration when a single protein supplement is fed. This argument fails to recognize that the protein compounds eaten by cattle are broken down and resynthesized by the rumen bacteria before they are digested and assimilated by the cattle. Consequently the "quality" of protein fed appears to be of relatively little importance in beef cattle rations. This viewpoint is supported by the results of experiments carried out at the Wisconsin and Kansas

stations, in which none of the protein mixtures used proved significantly superior to linseed meal. (See Table 154.)

The chief value of a mixture of proteins is to be found in its increased palatability instead of in its increased assimilation, as indicated by the results obtained at the Ohio station from feeding what is called an "all-purpose" protein supplement. This name has been applied because it has been found to be a very satisfactory protein supplement for balancing the rations of beef calves, dairy cows, lambs, swine, and laying hens. It consists of 30 parts by weight of dry-rendered tankage, 30 parts soybean oil meal, 20 parts cottonseed meal, 15 parts linseed meal, 2 parts finely ground limestone, 2 parts special steamed bone meal, and 1 part salt. In three experiments with beef calves, in which this supplement was compared in double series with a mixture of equal parts of linseed and cottonseed meal, a larger consumption of feed and correspondingly larger daily gains were obtained from the all-purpose supplement in every comparison. (See Table 155.)

Fortified Mixed Supplements. Whether or not cattle on finishing rations respond to fortified mixed supplements depends largely on the quality of the roughage being used. By fortified mixed supplements we mean that, in addition to the usual protein concentrates, they contain mineral and vitamin additions. In the experiment summarized in Table 156 corn cobs were the only source of roughage, since only ground ear corn was fed in addition to the supplements. In this case all the variations of a typical fortified mixed supplement which were tried resulted in improved gains over straight soybean oil meal and a simple mineral mixture of 2 parts steamed bonemeal to 1 part salt. Note, however, that no costs of gain were reduced. Rather they were increased, except when urea was used to cheapen the cost of the mixed supplement.

Perhaps most fortified mixed supplements are patterned after the now well-known Purdue Supplement A. The Indiana station has thoroughly tested this supplement under almost all practical feeding conditions, and it can be highly recommended when the ration consists of the lower quality roughages.

Formulas for the variations of Purdue Supplement A which were tested in the experiment summarized in Table 156 are given in Table 157. This type of supplement is usually fed at the rate of 2 pounds per day in finishing rations and from 1 to 1½ pounds in stocker and dry cow rations. A cattle feeder must decide for himself if a complete fortified supplement, with added vitamins, minerals, and hormones, is economical, not forgetting the built-in conveniences inherent in feeding such supplements.

Table 154

PROTEIN MIXTURES VS. SINGLE PROTEIN FEEDS FOR FEEDER CATTLE

	1st Test—Ohio Bimonthly Bulletin 166, 1934				2nd Test—Ohio Bimonthly Bulletin 173, 1935			
	1st Series		2nd Series		1st Series		2nd Series	
	L. S. M. ½ C. S. M. ½	All-Purpose Sup.*	L. S. M. ½ C. S. M. ½	All-Purpose Sup.*	L. S. M. ½ C. S. M. ½	All-Purpose Sup.*	L. S. M. ½ C. S. M. ½	All-Purpose Sup.*
Av. daily gain, lb.....	1.91	2.10	2 12	2.19	1.96	1.99	1.94	2.14
Av. daily ration								
Shelled corn.......	8 8	9.6	9 8	10 2	11.1	11.4	10.0	11.4
Protein sup........	2.0	1.7	2 0	1.7	1.0	.8	2.0	1.6
Corn silage........	7 8	7.7	7.7	7.7	8 0	8.0	8 0	8.0
Hay..............	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Molasses..........	....	....	.5	.5	. .	....	....	. ..
Hog gains per steer, lb.	30	43	39	48	75	80	79	105
Selling price per cwt. .	$6 90	$6 65	$6 80	$6 80	$8 65	$8.65	$8 50	$9 00

* Supplement: Dry-rendered tankage, 30%, soybean oil meal, 30%; cottonseed meal, 20%; linseed meal, 15%; powdered limestone, 2%; bone meal, 2%; salt, 1%.

Table 155

COMPARATIVE VALUE OF A SIMPLE AND A COMPLEX MIXTURE OF PROTEIN CONCENTRATES FOR FEEDER CALVES

	1st Test—Ohio Bimonthly Bulletin 166				2nd Test—Ohio Bimonthly Bulletin 173			
	1st Series		2nd Series		1st Series		2nd Series	
	L.S.M. ½ C.S.M. ½	All-Purpose Sup.*	L.S.M. ½ C.S.M. ½	All-Purpose Sup.*	L.S.M. ½ C.S.M. ½	All-Purpose Sup.*	L.S.M. ½ C.S.M. ½	All-Purpose Sup.*
Av. daily gain, lb.	1.91	2.10	2.12	2 19	1 96	1 99	1.94	2.14
Av. daily ration								
Shelled corn	8.8	9 6	9 8	10 2	11 1	11 4	10.0	11.4
Protein sup.	2 0	1.7	2 0	1.7	1.0	.8	2 0	1 6
Corn silage	7.8	7.7	7.7	7.7	8.0	8 0	8.0	8.0
Hay	1.6	1.6	1.6	1.6	1.6	1 6	1 6	1.6
Molasses	.	.	.5	.5				
Hog gains per steer, lb.	30	43	39	48	75	80	79	105
Selling price per cwt.	$6.90	$6.65	$6.80	$6 80	$8.65	$8.65	$8 50	$9 00

* Supplement Dry-rendered tankage, 30%, soybean oil meal, 30%, cottonseed meal, 20%, linseed meal, 15%, powdered limestone, 2%, bone meal, 2% salt, 1%.

Table 156

SELF-FEEDING GROUND EAR CORN WITH SOYBEAN MEAL AND FIVE FORTIFIED MIXED SUPPLEMENTS FOR FINISHING CATTLE*

November 9, 1956 to April 16, 1957—158 Days (Progress Report)

	8 Parts Ground Ear Corn to 1 Part Protein Supplement					
	Lot I Soybean Meal 41% C.P.	Lot II Soybean Meal Suppl. A 32% C.P.	Lot III Linseed Meal Suppl. A 29% C.P.	Lot IV Cottonseed Meal Suppl. A 29% C.P.	Lot V Soybean Meal Suppl. A with 5% Urea 32% C.P.	Lot VI Linseed Meal Suppl. A with 5% Urea 32% C.P.
Number of steers	12	11	12	12	12	12
			Growth Data			
Weight, Nov. 9, lb.	524	520	524	526	522	524
Weight, April 16, lb.	812	904	889	870	891	915
Av. total gain, lb.	288	384	365	344	369	391
Av. daily gain, lb.	1.83	2.43	2.31	2.19	2.33	2.47
			Daily Feed			
Ground ear corn and protein suppl., lb.	15.05	20.22	19.40	19.74	19.24	19.98
(Gr. ear corn, lb.)	13.37	17.97	17.25	17.55	17.10	17.76
(Prot. suppl., lb.)	1.68	2.25	2.15	2.19	2.14	2.22
Minerals, lb.	0.05	0.03	0.02	0.03	0.03	0.03
Salt, lb.	0.02	0.01	0.01	0.02	0.01	0.01
			Feed per 100 lb. Gain			
Ground ear corn and protein suppl., lb.	824	832	830	902	825	808
(Gr. ear corn, lb.)	732	740	746	802	733	718
(Prot. suppl., lb.)	92	92	93	100	92	90
Feed cost per cwt. gain, $	16.30	16.90	17.00	18.40	16.70	16.40

* Indiana Cattle Feeders Day Report, 1957.

Table 157

FORMULAS FOR VARIATIONS OF PURDUE SUPPLEMENT A*

Pounds per 1,000

Ingredient	Soybean Meal Suppl. A 32% C.P.	Linseed Meal Suppl. A 29% C.P.	Cottonseed Meal Suppl. A 29% C.P.	Soybean Meal Suppl. A with 5% Urea 32% C.P.	Linseed Meal Suppl. A with 5% Urea 32% C.P.
Soybean meal (44% c.p.)	650.5	. .	. . .	320.5	. .
Linseed meal (41% c.p.)	. .	650.5	. . .	. . .	330.5
Cottonseed meal (41% c.p.)	. .	. .	650.5	. . .	. . .
Molasses	140.0	140.0	140.0	140.0	140.0
Alfalfa meal (dehydrated)	140.0	140.0	140.0	140.0	140.0
Corn	. .	. . .	. . .	280.0	270.0
Urea feeding compound†	. .	. . .	. .	50.0	50.0
Bonemeal	52.0	52.0	52.0	52.0	52.0
Salt with cobalt‡	17.0	17.0	17.0	17.0	17.0
Vitamin A and D concentrate§	0.5	0.5	0.5	0.5	0.5
	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0

* Indiana Cattle Feeders Day Report, 1957.

† Urea feeding compound: 42% nitrogen, 262% protein equivalent.

‡ One ounce of cobalt sulfate added per 1,000 pounds salt.

§ Stabilized dry Vitamin A and D concentrate containing 4,540,000 U.S.P. units of Vitamin A and 567,500 U.S.P. units of Vitamin D per pound.

chapter 19

DRY ROUGHAGES AND THEIR USE IN FINISHING RATIONS

Roughages differ from concentrates principally in the amount of fiber or woody material that they contain. Most concentrates are very low in fiber; few of the common ingredients of the grain ration have more than 10 per cent of this material. Roughages, on the other hand, have a large amount of fiber, particularly when in the cured or dried state. Hay averages about 28 per cent and straw approximately 38 per cent of fiber when cut and harvested at the appropriate stage and time.

Fiber consists largely of cellulose, hemicellulose, and lignin, all complex, rather insoluble compounds that form the walls of plant cells. In young, immature plants the cell walls are comparatively thin; therefore the percentage of fiber is relatively small. With the approach of maturity, however, the cell walls become much thicker, resulting in a great increase in the fiber content.

In its chemical composition, fiber is a carbohydrate; that is, it is essentially like starches and sugars. However, because of its insoluble nature it is only partly utilized as a food nutrient by domestic animals. Obviously the first important step in the digestion of cellulose is the softening of the fibrous tissue through the absorption of large quantities of water. In cattle, cellulose is then partly converted to simpler, soluble compounds, principally volatile fatty acids, through fermentation brought about by the bacteria present in the rumen. Because of the capacity and structure of the digestive organs and their symbiotic relationship with rumen microflora, cattle are more efficient utilizers of roughage than non-ruminant animals. The methods by which roughages are broken down in the rumen have been discussed in more detail in Chapter 8.

Classification of Roughages. Roughages, like concentrates, may be classed as carbonaceous or nitrogenous, depending on the percentage of protein which they contain. Carbonaceous roughages include hay and pasture from the grasses, the straws from cereal grains, and

the stalks and leaves of corn and the sorghums. Nitrogenous roughages include the forage from legume crops.

Roughages may also be divided into dry roughages and green or succulent materials. For dry roughages the plants are cut when they are almost mature and are allowed to cure before being fed. For green roughages, green, immature crops are pastured by the animals, or the freshly cut green material is fed to cattle before it is withered by the sun and air. In silage the freshness or succulence has been preserved by storage, immediately after cutting, in specially designed, air-tight silos which prevent the loss of moisture.

Function of Roughage in the Fattening Ration. (1) *To Furnish Part of the Food Nutrients.* Although most of the gain made by cattle in the feed lot is credited to the concentrate portion of the ration, the part played by the roughage component should not be overlooked. At those farms on which cattle feeding is carried on largely for the purpose of utilizing unmarketable roughages, the efficiency with which the roughage is used in the production of gains often determines the success of the feeding venture.

In general, roughage is of most importance during the first part of the feeding period. It is then that the appetite of the cattle for such material is greatest, and large quantities can be fed with little fear of the cattle's overeating or going off feed. Except for short-fed cattle which, of course, should be got on a full feed of grain in the shortest time possible, roughage should compose the bulk of the ration for the first month or 6 weeks. Starting with a ration composed entirely of roughage, concentrates should be added gradually until the cattle are on a full feed of grain at approximately the end of the first fifth of the feeding period. At this time the ratio of grain to the weight of air-dry roughage should be approximately 3:2 for steers that are to be fed until they attain a choice finish. With a longer feeding period the use of roughage alone for the first few weeks is often practiced, especially with cattle that are thin and empty when they arrive at the feed lots. With feeding stuffs at ordinary prices, such a plan tends to reduce the total cost of feed without materially affecting the total gains made.

Although the ratio maintained between the grain and roughage at different stages of the finishing process varies considerably in practical feeding operations, the ratios given in Table 158 are fairly representative in this respect. Possibly more hay was fed than would be used if hay were scarce and had to be purchased, but no more than the farmer with his barns full of farm-grown hay would feed to mature steers finished in a leisurely manner. The rations fed were

Table 158

THE RELATIVE IMPORTANCE OF CONCENTRATES AND ROUGHAGE AT DIFFERENT STAGES OF THE FINISHING PROCESS*

Period	Average Daily Ration: Concentrates (Sh. Corn) (C.S. Meal)	Average Daily Ration: Roughage (Alfalfa or Clover Hay)	Ratio of Concentrates to Dry Roughage 1:	Total Digestible Nutrients†: From Concentrates	Total Digestible Nutrients†: From Roughage	Total Digestible Nutrients†: Total	Total Digestible Nutrients†: Per Cent of Total Furnished by Roughage	Total Therms Net Energy†: From Concentrates	Total Therms Net Energy†: From Roughage	Total Therms Net Energy†: Total	Total Therms Net Energy†: Per Cent of Total Furnished by Roughage
1st month	11.80 lb.	16 08 lb.	1.36	9.44 lb.	8.04 lb.	17.48 lb.	46%	10.35	5 87	16.22	36%
2d month	17.62	13.43	0.75	14.10	6.71	20.81	32%	15.46	4.90	20 36	24%
3d month	20.11	12.26	0.61	16.09	6.13	22.22	27%	17.65	4.47	22.12	20%
4th month	22.22	10.90	0.49	17.78	5.45	23.23	23%	19.50	3.98	23.48	17%
5th month	23.35	9.75	0.42	18.68	4.85	23.53	20%	20.49	3.56	24.05	15%
Average, approximately 150 days	19.00	12 52	0.66	15.20	6.26	21.46	29%	16.67	4.57	21.24	22%

* Average of 10 lots of two-year-old steers; Indiana Bulletins 153, 183, 191, 206.

† Computed from tables in Appendix of Morrison's *Feeds and Feeding*.

fairly good finishing rations, as is shown by the fact that the average daily gain of the 10 lots was 2.32 pounds. The smallest gain made by any lot was 2.06 pounds and the largest was 2.67 pounds.

(2) *To Furnish Bulk to the Ration.* Owing to the great capacity and peculiar structure of their digestive systems, cattle are particularly well-suited for consuming and utilizing a considerable amount of roughage. It has been demonstrated that mature cattle can exist, at least for several weeks, on an exclusive concentrate diet, but feeding experiments as well as practical experience show that they thrive much better if some roughage is supplied.

Roughage has formed the principal, if not the only, feed of cattle under natural conditions for countless generations. Through processes of natural selection cattle have developed a digestive system that functions well only when the organs are moderately distended by coarse, bulky materials. Cattle only partially masticate their food while eating. Upon being swallowed the food goes into the paunch where it absorbs large quantities of water and undergoes fermentation through the action of rumen bacteria. It is then regurgitated into the mouth in balls or boluses of about ¼ pound in size and thoroughly chewed by the resting animal before it is again swallowed for further digestion. Roughage is essential in the process of rumination. Cattle fed on an exclusive concentrate diet spend comparatively little time chewing their cuds. Hence the grain which they eat is imperfectly masticated and therefore not so thoroughly digested as it would be if part of the ration consisted of roughage.

In furnishing bulk to the ration, roughage tends to lighten or dilute the contents of the alimentary tract, thus exposing the particles of concentrates to a complete envelopment by the digestive fluids. Also, the presence of roughage insures a normal fullness of the large intestine, a condition that makes for the proper regulation of the bowels. Dry, carbonaceous roughages such as cereal straws and corn and sorghum stover, which are capable of absorbing large quantities of water, are especially valuable for neutralizing the effects caused by a heavy consumption of laxative feeds.

(3) *To Furnish Minerals and Vitamins.* A much larger concentration of minerals and vitamins occurs in the leaves and stems of plants than in the seeds. Consequently, roughages are a better source of calcium, potassium, and vitamins A and D than are the farm grains. Cattle fed an abundance of high-quality roughage seldom show any symptoms of mineral or vitamin deficiency, whereas such symptoms are occasionally encountered among cattle that are fed heavy grain rations and limited amounts of low-grade roughage.

The Amount of Roughage to Feed. There is great variation in the amount of roughage fed to feeder cattle. On the one hand we have cattle that receive little else besides silage and hay throughout the feeding period. In contrast with these are other cattle whose only roughage after they are on full feed is the cob particles in the ground ear corn fed. Neither of these extremes is often encountered, however. The common practice is to feed both roughage and concentrates, starting with a maximum of roughage and a minimum of concentrates and ending the feeding period with a minimum of roughage and a maximum of concentrates. However, because of variations in the supply of these two classes of feeding stuffs and variations in the length of time the cattle are to be on feed, considerable variation often exists between the ratio of concentrates to roughage at any given stage of the finishing process.

Ordinarily at least one component of the ration should be fed according to the appetites of the cattle. In other words, the cattle should be given all they will eat of that feed. Only by supplying some feed in such amounts is the feeder sure that the cattle are satisfied. Roughage is ordinarily used for this purpose because of its low cost and the slight likelihood of damage to the uneaten portion owing to exposure to the weather.

Feeding tests at the Nebraska station, in which 5 lots of cattle received shelled corn and alfalfa hay in ratios varying from 1:1 to 5:1 respectively after the first month of the feeding period, indicate that a ratio of 2 or 3 parts of corn to 1 part of hay is probably the most satisfactory for both calves and yearlings, since it results in the maximum consumption of total digestible nutrients. The lots fed grain and hay at the ratios 4:1 and 5:1 ate no more corn and, therefore, less hay than the lots fed at the narrower ratios; conse-

Table 159

Approximate Ratio of Grain to Roughage at Different Stages of the Feeding Period

Division of Feeding Period	Ratio of Grain to Roughage (Air-Dry Basis): Large Amount of Roughage Available	Amount of Roughage Limited	Long Feeding Period (Over 200 days)	Short Feeding Period (Approx. 90 days)
1st third	1 4	1 : 1	2 : 3	2 : 1
2nd third	2 : 3	3 : 1	3 : 2	3 : 1
Last third	3 : 2	4 : 1	3 : 1	5 : 1
Average for Entire Period	2 : 3	5 : 2	3 : 2	3 : 1

quently their gains were smaller and more costly. Excellent results were secured in one test from calves that were started on a ration of 2 parts of corn and 1 part of alfalfa hay, which was changed each month until, at the end of the feeding period, the corn and hay were fed at a 5 : 1 ratio. However, slightly larger and cheaper gains were made by another lot which was fed 2 parts shelled corn and 1 part hay throughout the test except during the first month, when all lots were being brought up to a full feed.[1]

Finishing Cattle Without Roughage. In times of roughage scarcity, large feeders who perforce must buy both grain and roughage occasionally omit roughage entirely from the ration because at such times roughages are always expensive relative to the total digestible nutrients which they contain. Seldom is this a profitable practice. Even though bulky grains such as corn-and-cob meal or ground oats are fed, they do not completely fill the place of roughage in the ration. The feeding of a small amount of hay or silage to cattle that have been fed only grain usually results in their consuming a larger amount of grain as well as the roughage. Immediately they begin to gain faster, partly because of a larger intake of food nutrients and partly because of better rumination and more thorough digestion of the feed eaten. Results of tests which demonstrate the effect of roughage upon feed intake and gain are shown in Table 160.

Roughage serves another important function in that it is a valuable source of vitamins, especially carotene and vitamin D. Long-fed cattle fed little or no legume hay or corn silage often show signs of vitamin A deficiency regardless of the amount of grain fed. Yearling steers fed a full feed of ground oats and cottonseed meal at the Illinois station showed characteristic symptoms of vitamin A deficiency after about 90 days. After the cattle were changed to a ration containing moderate amounts of silage and alfalfa hay the symptoms quickly disappeared.

Common Roughages Used in Finishing Rations. Roughage, especially in the form of hay, is grown and harvested throughout the country (see Figure 76). The roughage crop planted varies in species, quality, and yield, depending upon rainfall, soil fertility, and the choice of the farmer in some instances (see Figure 76). The great variety of roughages used in finishing rations can be subdivided into two broad classifications—leguminous and non-leguminous. The leguminous roughages are usually considered to be a good source of protein, minerals, and vitamins but only average to low in energy or total digestible nutrients. On the other hand the non-leguminous

[1] Nebraska Cattle Progress Reports 195 and 198.

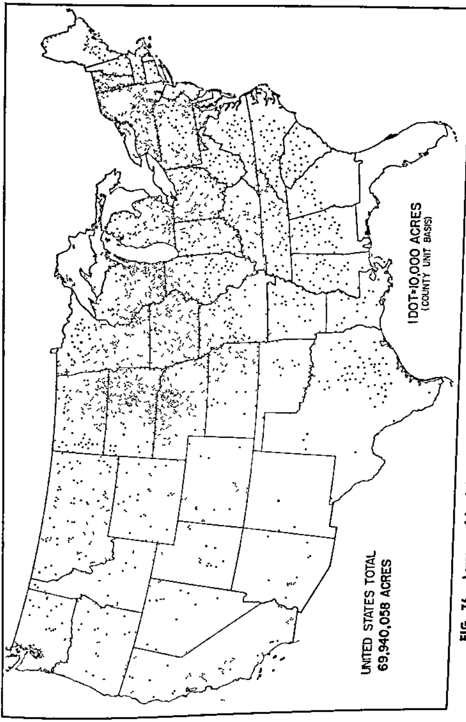

FIG. 76. Acreage of land from which hay was cut in 1954. (U. S. Department of Commerce.)

4. Legume forages are the highest in calcium content among all farm-grown feeds.
5. Legume forage excels in vitamin A (carotene) value.
6. Field-cured legume hay is rich in vitamin D.
7. Legume forage is rich in other vitamins besides carotene and vitamin D.
8. Legumes increase the yield and protein content of grasses growing in a legume-grass mixture.
9. Legumes are highly important in maintaining soil fertility.

It goes without saying that cutting at the proper stage and curing under good conditions are essential to insure that the above qualities are present in hay or silage made from leguminous forages. More will be said about these points later in this chapter.

Alfalfa Hay. Alfalfa is the most important tame forage crop grown and can be considered the standard by which all others are judged. New wilt-resistant and winter hardy varieties have been responsible for the almost universal adoption of this crop as the preferred forage. Undoubtedly its closest competitor among the legume forages is red clover.

Often the market price of alfalfa hay is 20 to 30 per cent above that of clover, indicating that it is regarded by most feeders as being superior to clover. This superiority is due to its higher protein content and to its freedom from dust and mold. Western-grown alfalfa is seldom damaged by rain. Consequently it usually retains its bright green color and does not spoil in the stack or bale. Hay made farther east, on the other hand, often encounters rain, which renders it discolored, dusty, and sometimes moldy. Obviously such hay is less palatable than hay put up under ideal weather conditions.

Occasionally alfalfa hay is criticized because of its somewhat laxative nature when fed in large quantities. Also its use is sometimes attended by acute bloating. Both these effects are more pronounced in calves than in older cattle. They can usually be overcome by combining the alfalfa with a carbonaceous roughage such as oat straw, stover, or timothy, or by feeding corn-and-cob meal instead of shelled corn.

There has been much discussion concerning the relative value of clover and alfalfa hays as roughage for finishing cattle. Unfortunately most of the comparisons that have been made have involved the feeding of sufficient nitrogenous supplements to make balanced rations without the additional protein furnished by the legume hays. Obviously under such conditions it would hardly be expected that the

difference in the protein content of the hays would be apparent. Such a situation is encountered in the Indiana experiments summarized in Table 161. In all the lots involved in these comparisons 2.5 pounds of cottonseed meal were fed per thousand pounds live weight, an amount that fully met the protein requirements of the cattle even though no legume hay was included in the rations. It is only reasonable to believe that alfalfa would make a more favorable showing if no protein concentrate were fed, or if it were so limited as to make the protein contained in the legume roughages of real need to the animals. This method of feeding was followed by the Illinois, South Dakota, and Wisconsin stations in the feeding trials reported in Tables 162 and 163. In all these comparisons of red clover and alfalfa the superiority of alfalfa is well established.

Clover Hay. Ordinarily when the term "clover hay" is used it refers to red clover or, what is even more likely, a mixed hay in which red clover, a legume, is mixed with timothy or some other grass. Red clover and timothy comprise the backbone of most rotation mixtures in cropping systems that call for leaving the legume-grass seeding down for only one or two years. When "longer" rotations are used, alfalfa and brome are apt to be substituted. Clover hay or, more properly, mixed clover-grass hay, is preferred by some feeders

Table 161

Comparison of Clover and Alfalfa Hay When a Surplus Amount of Protein is Supplied

(2-Year-Old Steers)*

Average of 4 Trials	Corn Cottonseed Meal Clover	Corn Cottonseed Meal Alfalfa	Corn Cottonseed Meal Clover Silage	Corn Cottonseed Meal Alfalfa Silage
Av. daily gain, lb.	2.38	2 27	2.32	2.35
Av. daily feed				
Shelled corn	16.2	15 8	12 6	12 5
Cottonseed meal	2.9	2 9	2.9	2 9
Legume hay	12.1	12.7	2.9	2.6
Corn silage	....	....	27.6	28.9
Av. feed per cwt. gain				
Corn	679	700	542	530
Cottonseed meal	122	128	126	125
Hay	509	558	126	111
Silage	...	.	11.90	12.28
Selling price per cwt.	$9 33	$9 29	$9.40	$9.375

* Indiana Experiment Bulletin 245.

Table 162

COMPARISON OF CLOVER AND ALFALFA HAY FOR FEEDER CATTLE

	Illinois Experiment Station* (2 yr.-old Steers — 126 Days)		South Dakota Experiment Station† (Yearling Steers — 91 Days)	
	Ear Corn Corn Silage Alfalfa Hay	Ear Corn Corn Silage Clover Hay	Corn Silage Alfalfa Hay	Corn Silage Clover Hay
Average daily gain (lbs.)....	2 38	2 05	2.49	2.29
Average daily ration:				
Ear corn	16 1	16 0	....	....
Corn silage..............	25 3	26.7	58 3	58.1
Legume hay.............	4 3	2.0	4.0	3.5
Feed per cwt. gain:				
Ear corn	675	783	....	....
Corn silage..............	1065	1302	23	25
Legume hay.............	181	100	1.6	1.5

* Illinois Mimeographed Report, 1911.
† South Dakota Bulletin 160.

Table 163

COMPARISON OF CLOVER AND ALFALFA HAY WHEN A LIMITED AMOUNT OF PROTEIN SUPPLEMENT IS FED*

(Yearling and two-year-old Steers — Average of 4 trials)

Average Time Fed, 161 Days	Lot 1 Clover Hay	Lot 2 Alfalfa Hay
Average daily gain (lbs.)...	2.19	2.22
Average daily ration:		
Corn	8.5	8.9
Cottonseed meal	1.5	.9
Legume hay....	5.3	5 3
Corn silage.	28.0	28.0
Feed per cwt. gain:		
Corn	394	407
Cottonseed meal	70	42
Legume hay................................	250	242
Corn silage.	1292	1264
Pork credit per steer	$7.53	$6.92
Selling price per cwt.	$10 00	$9.00

* Wisconsin Experiment Station; Mimeographed Reports of Calf Feeding Trials.

to alfalfa hay because it is less laxative. Since a protein concentrate is often fed, even though a legume roughage is used, because of its benefits as a palatability factor, the lower protein content of mixed hay is not serious. Clover or mixed hay is more palatable than alfalfa hay. When used along with silage it tends to cause a more normal state in the digestive tract. Obviously the relative proportion of clover and grasses affects the value of this type of hay from the standpoint of protein, mineral, and vitamin content.

Soybean Hay. Soybean hay is frequently fed to beef cattle in many parts of the Corn Belt. Since soybeans are annuals they are excellent to sow as an emergency hay crop to supplement light stands of clover and alfalfa which have resulted from unfavorable weather. Should it develop that the beans are not needed for hay they may be allowed to mature for seed.

Soybean hay compares favorably with clover and alfalfa hay for finishing cattle, when it is fed in limited amounts in combination with corn silage, mixed hay, oat straw, or some other non-laxative roughage.

Miscellaneous Legume Hays. Red clover is only one of several different kinds of clover, all of which are used for hay to some extent.

Alsike clover is usually considered more of a pasture than a hay crop because of its short growth and, consequently, low yield. However, when cut and harvested it produces a hay of exceedingly fine texture which is greatly relished by cattle. In its chemical composition it has slightly more protein than red clover but is somewhat lower in energy.

Mammoth clover resembles red clover in general appearance but is taller, coarser, and somewhat later-maturing. Although its yield of hay is heavy, the hay is often rather coarse and unpalatable. It contains the lowest percentage of protein found in any of the more common legume crops used for hay.

Lespedeza is grown extensively as a hay and pasture crop in the southern and southeastern states. The improved annual varieties, Kobe and Korean, grow to a foot or more in height and frequently yield as much as 2 tons of hay per acre. Lespedeza hay cut at the right stage of maturity and properly cured is an excellent roughage and compares favorably in feeding value with other legume hays such as soybean and alfalfa, as shown in Table 164. However, if it is allowed to become overly ripe, the stems become extremely tough and wiry and are neither palatable nor easily digested. The quality of such overripe hay is sometimes deceptive, since it often has a good green color and contains an abundance of leaves. *Serecia lespedeza*, a perennial variety, is much lower in value than the annual varieties and can hardly be recommended for use in finishing rations.

Table 164

VALUE OF LESPEDEZA HAY FOR FEEDER CATTLE

	Illinois Mimeo. Report, 1934		Illinois Mimeo. Report, 1935		Missouri Mimeo. Report, 1934	
	2-year-old Steers 84 days		Yearling Steers 53 days		Calves 112 days	
Hays Compared	Alfalfa	Lespedeza	Soybean	Lespedeza	Alfalfa	Lespedeza
Av. daily gain, lbs.	2.99	3.02	2.52	2.54	1.92	1.69
Feed per cwt. gain						
Shelled corn	609	603	578	505	279	319
Prot. conc.	39	39	40	38	23	27
Legume hay	244	241	208	203	494	443
Corn silage	....	....	....	....	113	129
Dressing percentage	60.2	61.5	57.6	56.3	....	....

Sweet clover is not a satisfactory hay crop. It is generally too coarse and woody to make a high-grade, palatable hay. Its coarse, rank growth makes it exceedingly difficult to handle and adds to the labor of baling it or putting it into the stack or mow. With favorable soil and weather conditions a crop of fair quality hay may be secured in the fall from sweet clover sown in oats or wheat the previous spring. Such hay is quite similar to alfalfa in color and texture. Cattle eat it readily as soon as they become accustomed to its characteristic flavor. Close clipping of the first-year growth in late September is not likely to result in any serious damage to the stand. Early mowing, however, cannot be recommended because of the danger of losing a high percentage of plants from winter killing.

Non-Legume Hays. Hays made from grasses may differ to some extent in palatability and feeding value in comparison with legume hays, but generally speaking, grass hays are similar to each other in chemical composition, regardless of species. Such factors as stage of cutting, curing methods, and yield affect the value of grass hays more than does the species. Thus it is advisable to grow the adapted and recommended grasses for a given locality, cutting them for hay when they are in their most nutritious state.

It has been well demonstrated that mixtures of legumes and grasses produce a greater tonnage of higher quality forage than do grasses

seeded alone, unless heavy nitrogen applications are used on the grass seedings. It seldom pays to grow straight grass meadows except, of course, in areas such as those where the likelihood of erosion precludes the growing of anything but perennial grass meadows, or where rainfall is apt to limit yields of tame meadows to an unprofitable level.

Grass hays, if cut at anything but the very early stage, resemble cereal straw in composition and are low in protein, phosphorus, and carotene. Early-cut grass hay from well fertilized meadows, on the other hand, may equal or approach the composition of legume or mixed hay.

Timothy. Many years ago timothy was the standard roughage for finishing cattle. At the present time most up-to-date feeders apologize for its use. From the standpoint of production, timothy has several advantages. It thrives reasonably well on a wide variety of soils; it is a perennial, and hence does not require frequent reseeding; the hay is very easily cured and as a rule is quite free from dust and mold.

Poor results are secured from timothy hay when it is fed without a nitrogenous supplement. Two-year-old steers fed for 126 days at the Illinois Experiment Station on corn, timothy hay, and corn stover gained 1.86 pounds per day, while a second lot receiving 2.55 pounds of gluten meal in addition made daily gains of 2.27 pounds. The use of gluten meal resulted in a marked reduction in the feed required per pound of gain and an increase of 75 cents per hundred in the

Table 165

A Comparison of Red Clover, Timothy, and Mixed Hay for Feeder Cattle

(Iowa Bulletin 253)

2-Year-Old Steers	Red Clover Hay	Mixed Hay	Timothy Hay and Oat Straw
Protein content of hay, %	10.3	7.7	5.0 Timothy 3.5 Straw
Av. daily gain, lb.	2.47	2.28	1.99
Av. daily feed			
Shelled corn	20.3	21.0	20.0
Cottonseed meal	2.0	2.5	3.0
Hay	8.7	8.5	6.0
Oat straw			0.3
Feed cost per cwt. gain	$10.65	$12.47	$13.45
Selling price per cwt.	8.25	8.15	7.90

selling price of the finished cattle.[3] An Iowa experiment which further demonstrates the low feeding value of straight timothy hay is summarized in Table 165.

Prairie Hay. Prairie hay made from native grass meadows in the Plains States resembles timothy in chemical composition and general value as a cattle feed. It is usually much cheaper than timothy, however, especially on the farms and ranches where it is produced. In the western states great quantities of prairie hay are made with little cost other than the labor involved in cutting and stacking. In such areas, prairie hay may well be combined with alfalfa, especially in the feeding of mature steers. It should be remembered that prairie hay varies greatly in the species of grasses and other plants that compose it. Occasionally such hay contains a large percentage of needle grass or other material which irritates the mucous lining of the cattle's mouths. Such hay, of course, should be avoided.

Prairie hay is non-laxative and has no tendency to produce bloat. This fact together with its freedom from mold makes it a popular roughage to feed cattle at stockyards and on the show circuit. Table 166 shows that prairie hay, when properly supplemented, has a place in the finishing ration.

Table 166

VALUE OF PRAIRIE HAY FOR FEEDER CATTLE

	Nebraska Bulletin 93 84 Days			Nebraska Bulletin 100 Average of 3 Experiments	
	Snapped Corn Prairie Hay	Snapped Corn Prairie Hay 50% Alfalfa 50%	Snapped Corn Alfalfa Hay	Shelled Corn Prairie Hay	Shelled Corn 90%, Linseed Meal 10% Prairie Hay
Daily gain, lb.	1.20	2.01	2 06	1.51	2.18
Feed per cwt. gain					
Corn	787	470	460	1,171	808
N conc.	.		. . .	. . . .	90
Hay	1,516	1,047	1,075	521	387

Hays made from the cereal crops and from Sudan or Johnson grass have a feeding value for finishing cattle comparable to timothy or prairie hay and usually are better utilized by breeding cattle or stockers.

[3] *Illinois Bulletin* 83.

Table 167

VALUE OF QUALITY HAY WHEN FED WITH A FULL FEED OF CORN-AND-COB MEAL TO FEEDER CATTLE*

	1950–1951 Experiment—259 Days on Test		1951–1952 Experiment—224 Days on Test	
Lot Number	8	1	1	6
	Poor Hay	Good Hay	Poor Hay	Good Hay
No. steers in lot at start	12	10	14	14
No. steers in lot at close	12	10	14	14
Av. wt. at start of test, lb.	636	630	472	475
Av. wt. at close of test, lb.	1,049	1,132	889	965
Av. daily gain, lb.	1.60	1.94	1.86	2.19
Av. daily ration:				
Corn-and-cob meal, lb.	13.6	15 0	11.1	12.4
Supplement, lb.	1.5	1.5	1.5	1.5
Hay, lb.	1.9	3 3	2.1	2.8
Minerals, oz.	2 0	1.9	1.3	1.3
Salt, oz.	0.5	0 6	0.6	0.7
Feed per cwt. of gain:				
Corn-and-cob meal, lb.	852 0	774 0	598.0	569.0
Supplement, lb.	94.0	77.0	80 0	68 0
Hay, lb.	117.0	169.0	112.0	127.0
Minerals, lb.	8 0	6 0	4 0	4.0
Salt, lb.	2.0	2 0	2 0	2.0
Corn-and-cob meal plus supplement, lb.	946.0	851.0	678.0	637.0
Cost per cwt. of gain, $	23.14	21.99	20.50	19.69
Dressing per cent	59.97	63 04		

* Ohio Research Bulletin 732, 1953.

Factors Affecting Hay Quality. Even though hay usually makes up considerably less than half of the total feeds fed to feeder cattle, the quality of hay fed may materially affect performance. Data such as those shown in Table 167 effectively demonstrate this point.

There is considerable disagreement concerning when hay should be cut to obtain the most feeding value. Early cutting favors a higher protein content, finer texture, less fiber, and higher digestibility. Late cutting, on the other hand, results in a larger tonnage, more total digestible nutrients, and usually more favorable weather for field curing of the first cutting.

There is no question that hay cut while the plants are high in protein and low in fiber is a much better feed from the standpoint of the cattle

Table 168

EFFECT OF DATE AND FREQUENCY OF CUTTING ALFALFA UPON THE YIELD AND QUALITY OF HAY*

Number of Cuttings	4	3	2
Approx. dates of cuttings	May 31 July 3 Aug. 7 Sept. 10	June 10–14 July 28 Sept. 10	June 20 Aug. 25
Total annual yield, lb.			
1926	8720	7800	6180
1927	6480	9840	6270
1928	5060	8660	6400
Average 1925–1932:			
Percentage of leaves in hay	51 8	44.5	38.1
Percentage of protein	19.4	16.8	15.2
Protein per acre, lb.	1633	1482	1022

* Ohio Bulletin 540

than hay that is more mature. This is especially true of non-legume hays such as prairie and timothy, which have a reasonably high protein content in the spring and early summer but are relatively low in protein upon becoming mature. Early-cut prairie hay (July 5–15) at the Nebraska Experiment Station[4] contained 7.2 per cent crude protein and 28 5 per cent fiber in comparison with 5.7 per cent protein and 30.9 per cent fiber for hay cut in August. Calves wintered on these hays and ½ pound of soybean oil meal per head made average daily gains of 1 01 and 0.52 pound, respectively, during a 106-day feeding period. Only 7.8 per cent of the July-cut hay was refused; whereas 10 8 per cent of the August-cut hay was refused by the calves. However, the yields of the early- and late-cut prairie hays were 1.12 and 1.43 tons per acre, respectively.

The feeding value and yield of alfalfa hay are affected not only by the date of the first cutting but by the frequency of cutting as well. Although 4 cuttings per season at the Ohio Experiment Station produced hay having more leaves and a higher protein content than hay obtained from 3 cuttings, the stand and, consequently, the yield deteriorated each year when 4 cuttings a year were made. (See Table 168.) Apparently, three cuttings made about June 10, August

[4] Nebraska Bulletin 385.

1, and September 10 constitute the best practice for most of the Corn Belt region when nutritive value, yield per acre, and permanence of stand are considered.

Method of curing and storage also may materially affect hay quality. Data on this subject are plentiful and those in Table 169 are typical. Naturally the amount of rainfall and cloudy weather affect curing time; therefore this factor is more of a consideration in some areas than others.

Table 169

EFFECT OF METHOD OF CURING AND STORAGE UPON QUALITY FACTORS IN HAY*

Method of Curing and Storage	Hours in Swath	Leaf Loss (%)	D.M. Loss (%)	Storage D.M. Loss (%)	D.M. Left to Feed as Standing Crop (%)
Field cure–rain damage	108	60	40	5	60
Field cure–no rain	54	35	20	5	79
Barn dried–no heat	29	25	20	10	81
Barn dried–heat added	29	25	15	3	85
Wilted silage	8	15	20	18	83

* U.S.D.A. Bureau Animal Industry-Inf., 142

Table 170

DIGESTIBLE PROTEIN CONTENT OF ALFALFA AND GRASSES IN RELATION TO MATURITY*

	Stage of Growth	Digestible Protein†
		%
Alfalfa	Immature	17.0
	After bloom	5.4
Kentucky bluegrass	Before heading	15.0
	After bloom	2.7
Orchard grass	Before heading	13.0
	After heading	4.9
Timothy	Pasture stage	13.9
	In seed	2.2
Mixed grasses	Immature	10.3
	At haying stage	4.7

* California Extension Service Circular 125.

† On 15 per cent moisture basis

Table 170 shows the effect of stage of maturity upon digestible protein content, while Table 171 shows the effect of method of harvesting and storing upon carotene content.

Other Non-Leguminous Dry Roughages. In the early days of cattle feeding, corn stover was one of the principal roughages used in finishing cattle. Large areas of corn were shocked in the fall to be fed to cattle during the winter months. Though considerable use is still made of this material in certain sections of the Corn Belt, it has been largely displaced by silage. Field choppers are used to harvest stover in emergency situations, but more often, stover is used for bedding rather than as a feed.

As a feed for finishing cattle, corn stover does not rank very high. It has a low percentage of protein and total digestible nutrients. Because of the large amount of fiber present it is rather unpalatable compared with most other farm roughages.

Sorghum Stover. The stover of the grain sorghums is essentially like corn stover in chemical composition and feeding value. However, because the stalks are of somewhat finer texture a greater percentage of the stalk is ordinarily eaten. When fed alone or with other dry carbonaceous roughage, sorghum stover is not very satisfactory for finishing cattle. When combined with legume hay or silage, much better results are secured. Even when legume hay constitutes half or more of the total roughage ration, some nitrogenous concentrate should usually be fed, since all stovers are low in protein. Sorghum stover, like corn stover and the grass hays, is more valuable in rations for cattle other than those on finishing rations.

Cereal Straws. Of the straws of the common cereal grains, oat straw is the most valuable as a cattle feed. When cut with a binder at the optimum time and stored before it is damaged by the weather, oat straw has a feeding value not greatly inferior to that of timothy

Table 171

CAROTENE CONTENT OF ROUGHAGES WHEN CUT, STORED, AND FED*

Roughage	Carotene (micrograms per gram dry matter) Cut	Stored	Fed
Early silage	354	341	140
Barn-dried hay	361	190	20
Field-cured hay	211	66	9
Late silage	216	238	84

* *Cornell Feed Service, No. 35.*

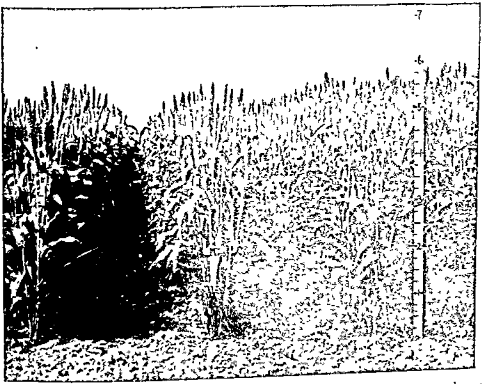

FIG. 77. A field of forage-type grain sorghum New hybrid forage sorghums mature earlier and yield more forage and more grain in comparison with older varieties. (U.S D.A.)

hay. However, when raked up after a combine it has little chaff or leaves and often has been damaged by sun and rains. In such condition it is not highly palatable, and comparatively small quantities are eaten. It is, of course, a carbonaceous roughage and should be fed to finishing cattle only when other constituents of the ration furnish the necessary protein. As stated elsewhere, the feeding of a small quantity of oat straw tends to reduce the tendency to bloat and scour that is occasionally noticed in cattle receiving a heavy feed of alfalfa hay. Also, its addition to a heavy silage ration satisfies, at a very low cost, the desire of the cattle for a dry roughage material.

Barley straw is somewhat inferior to oat straw for feeding purposes, principally because most varieties of barley are bearded, and the beards sometimes cause the mouths of the cattle to become sore.

Wheat straw has the lowest feeding value of any of the common cereal straws and should be regarded as an emergency feed for finishing cattle, to be fed only when ordinary roughages are scarce and high priced. Satisfactory gains were obtained at the Nebraska station from yearling steers that were fed a full feed of shelled corn,

cottonseed cake, and equal parts of wheat straw and alfalfa hay.[5]

Corn Cobs. Corn cobs have long been regarded as an important roughage for grain-fed cattle when fed in the form of corn-and-cob meal. However, their value was believed to lie chiefly in the volume and bulk that they gave the ration rather than in the digestible nutrients that they supplied. The fact that cobs are hard and woody and that they will not be eaten alone even by starving cattle has caused cattlemen to consider them almost worthless as a source of feed nutrients. Nevertheless, digestion trials have shown that cobs contain 45 pounds of digestible nutrients per hundredweight, or about the same as oat straw. Cobs have usually saved both grain and roughage in producing 100 pounds of gain in experiments comparing corn-and-cob meal with shelled corn. This is evidence, either that cobs possess a definite feeding value, or that their presence in the ration favors the utilization of the other components.

Experiments carried on at the Ohio, Iowa, and Nebraska stations, in which ground cobs were fed in addition to those present in corn-and-cob meal, show clearly that corn cobs are a valuable roughage material for finishing cattle. (See Table 172.) In the Ohio and Iowa tests, where both corn and hay were fed according to appetite, the added cobs replaced grain rather than roughage in both the daily ration and in feed consumed per hundred pounds of gain. But in the Nebraska experiments, where the roughage fed was sorghum silage, the addition of cobs had little effect upon the consumption of corn on a shelled basis but greatly reduced the consumption of silage. These results indicate that corn cobs are a better companion roughage for low-grade hay, which is eaten in small amounts, than for highly palatable hay and silage. It is possible that the additional bulk imparted to the Ohio and Iowa rations by the ground cobs resulted in a more complete digestion of the corn and protein concentrate.

Cottonseed Hulls. In the South, huge quantities of cottonseed hulls accumulate at the cottonseed oil mills. These are extensively used in livestock feeding throughout the cotton-growing states. Since they are low in protein and high in fiber their feeding value is low compared with most other roughage materials. According to chemical analyses[6] they have the remarkably wide nutritive ratio of 1:436; that is, they are extremely low in protein. In total digestible nutrients and in energy value they are approximately equal to oat straw.

The limitations of a ration composed of 4 to 8 pounds of cottonseed meal and a full feed of cottonseed hulls have been demonstrated

[5] Nebraska Bulletin 355

[6] F. B. Morrison, *Feeds and Feeding*, 22nd edition, 1956.

Table 172

THE VALUE OF CORN COBS AS A FEED FOR FINISHING CATTLE

	Ohio Mimeo. Series 52			Iowa Mimeo. AH Leaflet 165			Nebraska Bulletin 396		
	Calves and Yearlings (Average 3 Trials)			Yearlings (Average 2 Lots Each)			Yearlings (Average 3 Trials)		
	Shelled Corn	Ground Ear Corn	Ground Ear Corn +Cobs	Shelled Corn	Ground Ear Corn	Ground Ear Corn +Cobs	Shelled Corn	Ground Ear Corn	Ground Ear Corn +Cobs
Av. daily gain, lb	1.92	1.92	1 85	2 38	2 43	2.23	2 42	2 35	2.13
Av. daily ration									
Shelled corn	12.4	11.1	9 4	15 2	14 3	13 0	13.5	13 5	13.1
Corn cobs	....	2.5	4.2	...	2.7	5 4		3.1	6 2
Protein conc.	2 0	2 0	2 0	1.5	1.5	1 5	1.5	1.5	1 5
Hay	4.3	4 3	4.2	5 1	3 6	3 6		.	.
Sorgo silage	....	....	...	.			27.3	16.7	6 1
Total daily consumption of air-dry roughage (including cobs)	4.3	5.8	8.4	5 1	6 3	9 0	8 2*	8.1*	8 0*
Ratios of corn to roughage (including cobs)	2 9·1	1 6 1	1.1·1	3.4 1	2.6 1	1.4 1	1.6·1	1.7 1	1 6 1
Feed eaten per cwt. gain									
Shelled corn	631	552	478	657	651	576	559	574	613
Corn cobs	...	129	220		123	240		131	291
Prot. conc.	103	103	108	64	66	67	62	63	70
Hay	221	223	226	219	163	158			
Sorgo silage	...						1,126	712	286

* Sorgo silage reduced to 15 per cent moisture basis

repeatedly by southern experiment stations. Cattle fed on these feeds apparently do fairly well for 2 or 3 months, then gradually lose their appetites and become unthrifty. Formerly this condition was believed due to poisonous qualities of the cottonseed meal but it is now known that it is caused by nutritive deficiencies in both cottonseed meal and cottonseed hulls, especially deficiencies of carotene and calcium. If cottonseed hulls are fed with some other roughage such as legume hay, which contains adequate amounts of both these nutrients, or with a calcium supplement and sufficient yellow corn or corn silage to supply the necessary amount of carotene, the trouble is avoided. Results secured from feeding cottonseed hulls in properly balanced rations have compared favorably with those secured from other roughages, such as sorghum silage and prairie, peanut, and Johnson grass hays. (See Table 173.)

Table 173

VALUE OF COTTONSEED HULLS FOR FINISHING CATTLE

	2-year-old Steers 112 Days		Mature Steers 111 Days (Av. 3 Trials)		Steer Calves 185 Days		
Roughages Compared	Cottonseed Hulls	Corn Silage	Cottonseed Hulls, Johnson Grass Hay	Corn Silage, Johnson Grass Hay	Cottonseed Hulls	Cottonseed Hulls, Kafir Silage	Alfalfa Hay
Av. daily gain, lb	1.28	1.60	1.88	1.90	1.90	1.99	1.94
Av. daily feed							
Shelled corn	....	....	....	....	6.3	6.8	6.7
Cottonseed meal	7.5	7.5	6.4	6.4	2.8	2.5	1.0
Cottonseed hulls	26.0	....	23.5	....	5.6	2.9	....
Hay	..	..	3.0	3.0	....	....	5.6
Silage	..	30.6	....	48.4	....	6.6	....
Mineral supplement	..	....	....	....	0.2	0.2	0.2
Cost of roughages, per ton							
Cottonseed hulls	$6.00	..	$7.00	....	$5.00	$5.00	....
Hay	.	..	$12.00	$12.00	....	....	$7.00
Silage		$3.00	.	$5.00	....	$2.50	....
Cost of gain per cwt.	$13.74	$9.87	$11.35	$12.80	$4.88	$4.77	$4.36
Source of data	North Carolina Bulletin 222		Mississippi Bulletin 278		Oklahoma Mimeographed Report, 1933–34		

As greater diversification of crops has been practiced by southern farmers, the use of cottonseed products as the entire ration for finishing cattle has rapidly declined. Cottonseed meal is being combined with corn, and cottonseed hulls are being fed with other roughages, particularly silage and legume hay. The long growing season makes it possible to grow a great variety of valuable forage crops so that farmers in the Cotton Belt have a choice of several good roughages that are more satisfactory than cottonseed hulls for finishing cattle.

chapter **20**

SILAGE AS A FEED FOR FEEDER CATTLE

The first silage experiment reported in a United States government publication (1875) was that of Professor Manly Miles of the University of Illinois, who made studies of cornstalk and broomcorn silages stored in pit silos. However, extensive use of corn silage in beef cattle feeding did not begin until about 1910. Before that time it was generally believed that silage was a feed mainly for dairy cows. It was thought that its succulent nature would produce a marked looseness of the bowels, a very undesirable condition for steers on full feed. However, the results obtained by its use both at agricultural experiment stations and in feed lots of progressive cattlemen were so favorable that the feeding of silage to feeder cattle soon became a common practice throughout the Corn Belt.

By no means has the use of silage been confined to the Corn Belt. Although it is true that corn was the first and is still the principal crop used in the making of silage, many other crops are ensilaged in those regions of the country where corn cannot be grown successfully. In the arid West and Southwest the sorghums furnish an enormous tonnage of silage. Also a large amount of silage is now made from alfalfa, oats, field peas, clover, cowpeas, soybeans, rye, Sudan grass, and other farm crops. Indeed, it appears that the time will soon be at hand, if, in fact, it is not already here, when silage will be the principal roughage used in beef production both in the Corn Belt and throughout the United States.

Principles of Making Silage. "The fundamental principle underlying all attempts at the conservation of any crop is the desire to preserve the material at its best stage of growth for use at those seasons when the fresh crop itself is not available."[1] It is well to remember that a silage cannot be better than the crop that was harvested to make it. In fact, it is unfortunately true that much silage is considerably less valuable than the original crop from which

[1] A. J. G. Barnett, *Silage Fermentation*, Academic Press, Inc., 1951, p. 1.

it was made. This fact is due, first of all, to excessive losses during fermentation and from top spoilage and, secondly, to unfavorable aroma and conditions which reduce consumption to low levels. An understanding of the chemical changes which forage undergoes during ensilaging should serve to emphasize the important steps necessary in making good silage. Stepwise, these chemical changes occur in the following order, with considerable overlapping:

1. Respiration of the plant cells of the chopped forage particles for a few hours, resulting in the consumption of much of the trapped oxygen and the production of carbon dioxide and heat. Plant enzymes contained in the forage are also active during this phase.
2. Production of lactic and acetic acids by anaerobic (living in the absence of oxygen) bacteria, provided sufficient soluble carbohydrate material is available for this bacterial fermentation to proceed. This process goes on for several days to several weeks depending upon the rate of acid production. When a certain pH (about 4.0) or acidity is reached, fermentation almost stops, with the silage undergoing little further change. The length of time required to reach the desired pH determines, to a large degree, the loss in energy due to fermentation.
3. Should the proper pH not be reached because of insufficient soluble carbohydrate in the forage, then butyric acid-producing bacteria become active and further reduce the energy content of the silage. A foul-smelling, slimy, unpalatable silage results when this type of fermentation occurs. Furthermore, the butyric acid-producing organisms may attack the proteins, converting them to volatile fatty acids and ammonia.

In summary, the two important essentials in making high-quality, palatable silage with reduced nutritive losses from excessive fermentation are: (1) pack the silage well so as to exclude oxygen, thereby reducing cell respiration and enzyme activity; (2) add some type of soluble carbohydrate material to promote acetic and lactic acid production and to inhibit the activity of butyric acid-producing bacteria.

Extent of Losses in Making Silage. For convenience of discussion, silage losses can be divided into (*a*) seepage losses, (*b*) fermentation losses, and (*c*) top spoilage. Extent of seepage loss depends on the amount of moisture present (moisture within the plant itself, water added at silo filling time, and added moisture in the form of rain or snow), on pressures exerted, and on whether or not the excess moisture, containing soluble material, may drain or seep from the silo. Seepage losses can be eliminated or reduced by (1) wilting the freshly cut forage to approximately 30 per cent dry matter while it lies in the freshly

cut swath or in a loose windrow, or (2) by cutting forage only after it has matured sufficiently to contain above 28 to 30 per cent dry matter, or (3) by adding an absorbent material such as ground ear corn or ground corn cobs. Seepage losses of nutrients are not as high, percentagewise, as the apparent loss in weight, since most of the liquid seeping from a silo is water. Nevertheless, seepage losses of actual nutrients from tower silos may run as high as 10 per cent of the dry matter, mostly in the form of soluble carbohydrate material. In trench, bunker, or stack silos, seepage losses are usually lower, especially if rainwater is diverted. Under ideal conditions no seepage need occur. The possibility of seepage should be allowed for by

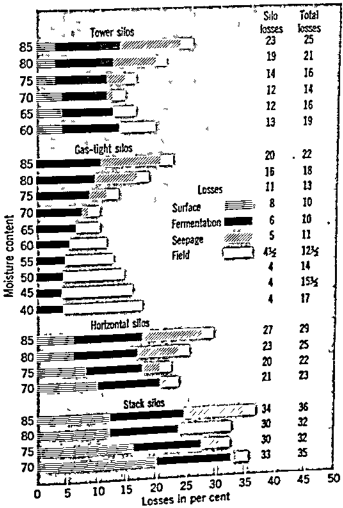

FIG. 78. Effect of moisture content on dry matter losses in legume-grass silages. (A. T. Hendrix, Agricultural Research Service, U.S.D.A.)

locating the silo so as to provide drainage for the foul-smelling liquid which may sometimes result.

The extent of fermentation losses, usually the greatest source of loss in kinds of silage other than corn and sorghum, may well go as high as 25 per cent of the total dry matter, but ranges from 5 to 10 per cent in most silages. The extent of fermentation loss depends upon availability of a soluble carbohydrate for bacterial fermentation or conversion to the volatile fatty acids, lactic and acetic, or the addition of mineral acids themselves and the effectiveness with which air is excluded from the silage.

Top spoilage losses vary tremendously and are most apparent of all losses since they are readily observed. The extent of these losses, which may vary from nearly zero to as high as 20 to 25 per cent, depends on how well the fresh material is packed, on whether or not rain or snow falls on the surface of the silage, and on whether or not a covering material of some sort is used.

Field losses, due to loss of dry leaves resulting from over-maturity or excessive wilting, may become an important loss in legume silages in some situations.

Total losses from all sources can be expected to run an average of 10 to 15 per cent for corn or sorghum silages stored in good tower silos to an average 15 to 25 per cent for straight legume or legume-grass silages. Use of oxygen-free storage or air-tight silos reduces losses by at least one-half, whereas total losses may go as high as 35 per cent in poorly located and constructed surface silos. Figure 78 shows the effect of moisture content and type of silo on the magnitude of dry matter losses in legume-grass silage.

Preservatives. Preservatives, additives, or conditioners are added to legume and grass silages for one or all of four reasons: (1) to hasten the production of lactic and acetic acids in order to prevent undue fermentation losses, (2) to directly lower the pH and prevent the more adverse forms of fermentation, (3) to correct certain nutritional deficiencies that may be inherent in the silage, (4) to improve the odor and palatability of the silage.

Preservatives may be divided into two broad categories: first, the carbonaceous or carbohydrate materials such as molasses and corn, and, second, the mineral acids, chief of which today is sodium metabisulfite. Good silage can be made without preservatives and much silage is so made. However, those who are inexperienced in making silage, especially grass and legume silages, would do well to investigate their use.

The economy of preservatives is difficult to determine for each and

Table 174

RATES OF PRESERVATIVE APPLICATION WITH DIFFERENT FORAGES

Kind of Crop	Suggested Pounds per Ton of Crop: Molasses*	Corn-and-Cob Meal†	Sodium Metabisulfite
Grasses	40–60	100–150	5
Cereals	25–50	75–100	5
Legume-grass mixtures	50–100	125–150	7.5
Legumes	75–100	150–200	10
Corn and sorghum	none	none	none

* If dried molasses preservatives are used, reduce amounts by 50 per cent.
† If ground shelled corn is used, reduce amounts about 10 per cent.

every farm. The carbonaceous preservatives can be justified without question because they are recovered in the silage as a carbonaceous concentrate with at least 85 per cent of their energy or feeding value being retained. On the other hand, although such preservatives as sodium metabisulfite do an excellent job of reducing losses in the silo and in improving (sometimes but not always) palatability, they make no further contribution to the ration. Application of sodium metabisulfite and similar material presents a mechanical problem since the amount added is so extremely small.

Table 174 gives recommended levels of preservatives when the material is cut with a direct-cut field chopper. If wilting is practiced, the practice of using preservatives is questionable. Additional amounts of cob, up to 200 pounds, are often used to reduce seepage of high-moisture silages. Corn or other high-energy feeds may be added up to as high as 50 per cent of the weight of the silage in order to balance a finishing ration with respect to energy content Urea or oilseed meals are also added at times to increase the protein content of corn silage.

Sealing the Silo. Many farmers make no attempt to seal their silos but allow a natural seal of rotted and moldy silage to form at the top, through which little air gains access to the silage below. This is a wasteful practice because the amount of spoiled silage, which must be discarded when the silo is opened, may easily represent 5 to 10 per cent of the total weight of green forage stored. This loss of feed may be greatly reduced by leveling the surface of the silage, tramping the silage thoroughly to exclude the air from the top layer, and covering the silage with plastic or roofing or building paper

weighted down with 4 or 5 inches of earth, limestone, or sand. Ordinary agricultural limestone makes an especially good seal on uncovered silos because of the tight, impervious crust which it forms after it is wetted by a heavy rain. Well-packed silage stored to a depth of 40 to 50 feet and covered with a felt roofing, limestone, or plastic seal should not shrink in weight more than 3 to 5 per cent due to top spoilage.

Trench silos often are sealed by covering the silage with 6 or 8 inches of earth. The practice of placing a layer of straw between the silage and earth cover is not recommended since the air trapped in the straw prolongs fermentation of the silage below. Usually there is enough spoiled silage when the silo is opened to prevent any contamination of the good silage with the earth used as a cover. Often the earth together with the spoiled silage is removed with a blade on the front of a tractor and is left near the edge of the silo to be used as a cover the following year.

Kinds and Types of Silos. The most common type of silo is the upright silo, 12 to 16 feet in diameter and 30 to 50 feet high. Vitrified or glazed tiles and concrete staves are the most popular building materials, although many monolithic concrete silos and a few wooden stave silos erected many years ago are still serviceable and are being used. Metal silos are increasing in number, especially the glass-coated steel silo called the "Harvestore," which has the unique feature of being airtight. Consequently, the ensilaged forage undergoes little loss of vitamins and other nutrients as the result of fermentation. The chopped forage is blown into the silo through a hole in the roof and is removed at the bottom of the silo by a special bottom unloader

Table 175

EFFECT OF VARIOUS TYPES OF SILO SEALS ON SHRINKAGE OF CORN SILAGE*

	Not Sealed	Heavy Felt Roofing Paper Covered with Approximately 6 Inches of: Loam Soil	Sand	Agricultural Limestone
1. Number of silos averaged	12	4	1	8
2. Av. days between filling and opening	206	365	280	202
3. Av. tons green corn stored	79.3	80 6	84.4	80.2
4. Av. tons silage fed	65.4	74.5	80.6	77.1
5. Av. shrinkage, percentage	17.5	7.6	4.6	3.8

* Illinois Station Mimeographed Report, April 25, 1941.

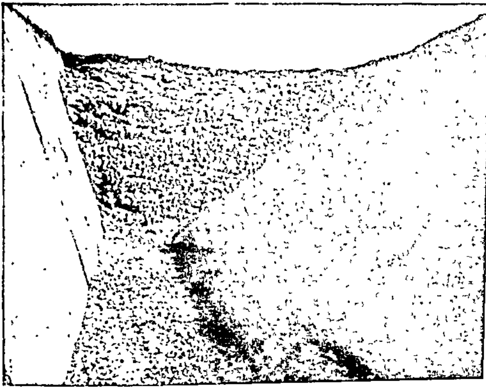

FIG. 79. A trench silo with poured-in-place concrete walls. (University of Illinois.)

designed for that purpose. A valve in the top attached to an inflatable "breather bag" under the roof serves to maintain the same pressure within the silo as exists on the outside. The manufacturer claims that small quantities of green forage may be put into the "Harvestore" from time to time during the summer with little or no spoilage between the different layers.

Inasmuch as the cost of a silo made of concrete, or similar material, is high, various attempts have been made to provide less expensive structures for the storage of silage. Perhaps the most common form used is the trench silo, which consists of a long straight-sided ditch 8 to 20 feet wide, constructed on a 5- to 10-degree slope in order that surface water seeping into the trench may drain out at the lower end. An important advantage of the trench silo, besides its inexpensive construction, is its low cost of filling. No special equipment is required at the silo since the trucks that are used to haul the forage from the field harvester are driven into the silo, where they dump and spread the load with little or no hand labor.

Driving the truck over the silage during filling assists in packing the material, but packing with a tractor is recommended. The

principal disadvantages of the trench silo, if unlined, are the tendency of the trench to become wider each year through the crumbling of the walls, and the difficulty of maintaining roads to the silo over which the silage may be hauled to the cattle during bad weather. Except in areas of light rainfall, the walls and floors of trench silos should be made of concrete to prevent serious erosion damage by heavy rains during the spring and summer when the silos are empty.

Many farmers are having fairly good results from storing silage in large, carefully made stacks in the open, with or without retaining walls, without protection to either the tops or sides of the piles. The losses encountered from the spoilage in these bunker or surface silos are claimed to be less than the annual interest and depreciation charges on a conventional type of silo. This method of storage is commonly used for the preservation of pea vines, cannery refuse, beet tops, and other silage materials of low feeding value. It may well prove to be the best method of preserving grasses and legumes because, as some feeders claim, spoilage costs are lower than silo costs. Labor costs of feeding from surface silos are lower because tractor-mounted scoops are used.

Costs in Making Silage. The total costs of making and feeding silage can be grouped under the following items (*a*) depreciation of

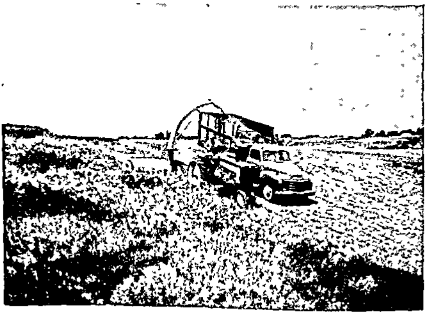

FIG. 80. Direct-cutting an alfalfa-brome mixture for silage. (John Deere, Moline, Illinois.)

silo, filling and feeding equipment; (*b*) interest on investment in silo and equipment; (*c*) maintenance and repair of silo and equipment; (*d*) taxes; (*e*) silage losses, including field losses; (*f*) net cost of preservative; (*g*) labor cost of filling silo and feeding silage. Such costs naturally vary considerably and depend principally upon the type of silo and size of operation. The larger capacity silos have a real advantage in that fixed costs, such as those for filling and feeding machinery, can be spread over more tons of silage or larger numbers of cattle fed. Table 176 shows how size and type of silo affect estimated silo costs and cost of silage losses per ton.

The estimated total cost per net ton fed or, in other words, the estimated total cost from standing crop to feed bunk per ton actually fed, is shown in Table 177. Some operators will do this job more cheaply but some also have higher costs, mainly because losses are greater and inefficiencies in operating expensive silo-filling equipment are more frequent. Cooperative ownership of silo-filling equipment is practiced in many areas and neighbors often trade work at silo filling time. The difficulty with this arrangement is that the optimum time for harvesting a crop may arrive simultaneously on all farms in the neighborhood.

The Place of Silage in the Finishing Ration. Whenever cattle are given a liberal amount of grain, any silage fed should be considered a part of the roughage ration. Its use should therefore be in accordance with the well-recognized rules for the feeding of roughage discussed in Chapter 19. Because silage often contains some corn or other concentrate, men inexperienced in its use often make the mistake of treating it as a concentrate. Beginning with a small amount of silage, they gradually increase the allowance per day throughout the feeding period when, as a matter of fact, the reverse of this procedure usually should be followed. In view of the fact that silage contains little corn or other concentrate in proportion to its weight and bulk, it is manifestly impossible for steers to consume any great amount of grain and silage at the same time. The logical procedure to follow is to feed the maximum amount of silage during the first part of the feeding period, decreasing the amount from month to month, so as to permit a larger consumption of concentrates.

Effect of Silage on Consumption of Grain. Except when it is given in very small quantities, the use of silage lessens slightly the consumption of grain. The two probable reasons for this decrease in consumption are that well-preserved silage is more palatable than most dry roughages (and thus competes more actively for the appetite of the steer), and that the concentrate present in the silage naturally

Table 176

Estimated Cost per Ton Capacity of Silos*

Type of Silo	Average Initial Cost ($) per Ton Capacity		Estimated Life (yr.)	Annual Cost† per Ton (% of Initial Cost)	Annual Cost ($) per Ton Capacity—Silo Only		Estimated Silage Losses (%)	Annual Silo Costs‡ per Gross Ton ($)	
	100 T.	200 T.			100 T.	200 T.		100 T.	200 T.
Tower									
Wood stave	12.00	10.00	25	8.7	1.04	0.87	14	1.74	1.57
Monolithic concrete	12.00	9.00	35	7.4	0.89	0.67	14	1.59	1.37
Concrete stave	13.00	10.00	30	7.8	1.02	0.78	14	1.72	1.48
Clay tile stave	22.50	17.50	45	6.5	1.46	1.04	12	2.06	1.64
Galvanized steel	17.50	13.50	40	6.7	1.17	0.90	12	1.77	1.50
Gas-tight steel	32.00	25.10	40	7.0	2.24	1.76	5	2.49	2.01
Horizontal									
Unlined trench	1.00	0.80	5	26.0	0.26	0.21	23	1.41	1.36
Wood wall trench	6.00	4.50	15	11.5	0.69	0.52	20	1.69	1.52
Concrete trench	7.60	7.00	25	8.5	0.65	0.60	20	1.65	1.60
Tilt-up horizontal	6.00	5.20	25	8.5	0.51	0.44	20	1.51	1.44
Wood wall bunker	7.50	5.00	20	9.7	0.72	0.38	20	1.72	1.38
Miscellaneous Silos									
Welded wire, paper	1.00	0.80	3	36.8	0.47	0.38	20	1.47	1.38
Plastic film envelope	1.50	1.40	1	103.5	1.56	1.45	5	1.81	1.70
Stack	0.05	0.04		103.5	0.05	0.04	33	1.70	1.69

* A. T. Hendrix, Agricultural Research Service, U.S.D.A., 1958.

† Includes depreciation, maintenance, interest on investment, and taxes.

‡ Includes spoilage loss with green forage crop at $5.00 per ton.

Table 177

SUMMARY OF ESTIMATED COSTS OF HARVESTING, STORAGE, STORAGE LOSSES, AND FEEDING OF SILAGE BY DIFFERENT METHODS PER NET TON*

(Silo capacity, 200 tons)†

Type of Silo	Silo Cost per Year, Net Ton ($)	Storage Losses per Net Ton ($)	Filling Costs per Net Ton ($)	Silo, Storage Losses and Filling Costs per Net Ton ($)	Estimated Feeding Costs per Net Ton ($)	Total Costs, Standing Crop to Feed Bunk ($)
Tower						
Wood stave	1 01	0.81	2.65	4.47	1.05	5.52
Monolithic concrete	0.78	0 81	2.65	4.25	1.05	5.30
Concrete stave	0.91	0 81	2.65	4.38	1.05	5.43
Clay-tile stave	1.18	0.68	2.69	4.45	1.05	5.50
Galvanized steel	1.02	0.68	2.69	4.30	1.05	5.35
Gas-tight steel	1.85	0 26	2 69	4.41	1.09	5.50
Horizontal						
Unlined trench	0.27	1.49	2.69	4.46	0.48	4.91
Wood wall trench	0.65	1.25	2.59	4.48	0.08	4.56
Concrete trench	0.75	1.25	2 59	4.58	0.08	4.66
Tilt-up horizontal	0 55	1.25	2.59	4 39	0 08	4.47
Wood wall bunker	0.48	1.25	2 59	4.32	0.08	4.40
Miscellaneous Silos						
Welded wire, paper	0.48	1.25	3.00	4.72	0.48	5.20
Plastic film envelope	1.52	0.26	2.53	4.32	0.48	4.80
Stack	0 06	2.46	3.58	6 10	0.48	6.58

* A. T. Hendrix, Agricultural Research Service, U.S.D.A., 1958.

† Forage crop estimated value—$5 00 per ton in field.

tends to replace part of that in the grain ration. The use of corn silage in moderate amounts decreases the consumption of the corn fed as concentrate by approximately 10 per cent of the weight of the silage fed, whereas the shelled corn content of the silage usually is 15 to 17 per cent of the weight of silage eaten. Consequently the feeding of silage in moderate amounts usually results in a somewhat larger total consumption of corn than would be realized from a non-silage ration. This is illustrated in Table 178.

The Amount of Silage to Feed. Silage varies so much in its moisture content that it is impossible to lay down definite rules for the amount that should be fed. Some men put the crop into the silo when it is comparatively green, whereas others wait until it is fairly mature. Naturally the greener silage contains more water. Also, it frequently happens that silage in a given silo varies greatly in moisture content from top to bottom. This situation is particularly likely in a large silo which requires several days to be filled, or in a silo containing silage made from rather dry forage to which considerable water has been added. Unless the flow of water is carefully regulated, some of it filters down through the silage, leaving the material at the top only

Table 178

Effect of Silage upon the Consumption of Grain
(Two-year-old Steers)

	Indiana Experiment Station	Number of Trials Averaged	Average Daily Consumption: Shelled Corn, pounds	Average Daily Consumption: Corn Silage, pounds	Corn Present in Silage, pounds*	Total Corn Consumed, pounds
I.	Shelled Corn, C. S M. Clover Hay, Corn Silage	10	14 2	25.1	3.8	18.0
	Shelled Corn, C S. M. Clover Hay	10	17.1	....	....	17.1
II	Shelled Corn, C. S. M. Corn Silage	5	14.5	29.0	4.5	19.0
	Shelled Corn, C. S. M. Clover Hay	5	17 5	....	....	17.5

*Assuming that 15% of weight of silage is corn.

moderately moist, whereas that near the bottom is saturated. Consequently, any recommendation that may be made as to the amount of silage to feed should be regarded only as a rough estimate.

The best index to follow in determining the amount of silage to feed is the appetite of the cattle. Knowing the approximate amount of grain that should be consumed at a given stage of the feeding period, one may feed as much silage as does not decrease appreciably the consumption of grain. Less than this amount may, of course, be fed if some form of dry roughage or pasture is supplied, but the use of greater amounts is almost certain to result in smaller daily gains and lower finish.

Although from the standpoint of the cattle there is no minimum amount of silage to feed, there are certain practical objections to using this material in small quantities. The principal items in the cost of silage, as mentioned earlier, are the labor, machinery, and storage charges. These items decrease rapidly per ton as the amount of silage made increases. Consequently silage is a much cheaper feed when put up in large quantities. Also considerable labor is involved in the feeding of silage compared with most other roughages; but this labor decreases per ton with the amount of silage fed. Consequently, if silage is to prove a cheap and economical feed, it must be fed in relatively large quantities. Except in special situations, silage, if used, should furnish 60 to 80 per cent of the roughage ration on an air-dry basis.

Owing to the high water content of silage, inexperienced feeders find it somewhat difficult to determine its dry roughage equivalent.

Table 179

APPROXIMATE AMOUNTS OF CORN SILAGE TO FEED AT DIFFERENT STAGES OF THE FEEDING PERIOD

	Approx. Initial Weight, pounds	First Month of Feeding Period (Little or No Grain)			First Month of Middle Third of Feeding Period (Full Feed of Grain)			First Month of Last Third of Feeding Period (Roughage Limited)		
		Shelled Corn, pounds	Corn Silage, pounds	Legume Hay, pounds	Shelled Corn, pounds	Corn Silage, pounds	Legume Hay, pounds	Shelled Corn, pounds	Corn Silage, pounds	Legume Hay, pounds
1. Calves . .	400	..	15	4	9	8	2	12	6	2
2. Yearlings	700	3	25	5	12	15	3	15	12	2
3. 2-year-olds	900	5	35	6	14	20	4	17	18	3

Because of the great variation in moisture this equivalent can only be approximated, but for practical feeding purposes it may be roughly estimated by dividing the weight of fresh silage by three. This means that cattle fed 30 pounds of silage are consuming approximately the same amount of roughage as cattle eating 10 pounds of hay.

Table 179, based on this ratio, has been compiled in an effort to give the inexperienced feeder an idea of the approximate amounts of silage to feed at different stages of the feeding period. With a longer feeding period the decrease in the amount of roughage fed would, of course, be made more slowly.

Silage Versus Dry Roughage. When silage is supplemented with the proper amount of nitrogenous concentrate to balance the ration, it compares favorably as a roughage with clover or alfalfa hay as shown in Table 180.

Its principal advantages over these dry roughages are its certainty of supply—the total failure of corn or sorghum to make a silage crop is extremely rare—and the opportunity it affords to utilize a large amount of roughage that has no market value. The chief disadvantages of silage compared with legume hay are the comparatively large amount of labor and equipment required for its harvest and storage and the necessity of making a cash outlay for commercial feeding stuffs to furnish the protein needed to balance the ration. Comparatively little additional protein is needed with clover hay as the roughage, and still less with alfalfa. Corn or sorghum silage, however,

Table 180

COMPARISON OF CORN SILAGE AND LEGUME HAY AS ROUGHAGES FOR STEERS ON FULL FEED

	Number of Trials Averaged	Daily Gain, *pounds*	Feed per Cwt. Gain			
			Corn, *pounds*	C.S.M., *pounds*	Silage, *pounds*	Hay, *pounds*
I Indiana: 2-year-olds						
Corn, C.S.M., Corn silage	5	2.42	600	115	1,240	...
Corn, C.S.M., Clover hay	5	2.35	742	118	....	456
II Illinois: calves						
Corn, C.S.M., Corn silage	5	2.08	476	70	377	96
Corn, alfalfa hay	5	1.97	525	73	....	254

requires a daily allowance of *1 to 2 pounds of protein concentrate* per steer if satisfactory results are to be obtained from their use.

Whether corn or sorghum silage or legume hay will prove most satisfactory for a particular feeder depends both upon his method of feeding and handling his cattle and upon the amount of legume hay and other dry roughages available. As stated elsewhere, silage is unsurpassed as a roughage for common or medium steers that are to be fed only a short time before being sent to market. It is also well suited for cattle of any grade that are to be finished in a leisurely manner over a long period. Legume hay, on the other hand, is preferred by many feeders for putting a high finish on well-bred steers within 120 to 140 days and for finishing calves within a period of 6 to 8 months. Legume hay is much more satisfactory than silage if the cattle are fed their grain in self-feeders. By using large racks or mangers, hay can be self-fed by filling the mangers as needed. Silage, on the other hand, must be fed daily. Self-feeding surface silos are fairly satisfactory for feeding stockers but generally prove unsatisfactory for feeder cattle. The cost of constructing a silo and the outlay for harvesting and feeding machinery amount to a considerable expense which is justified only when the tonnage of silage made and used is reasonably large. Otherwise the machinery and storage charge per ton of silage is so high that silage ceases to be an economical feed. Silage is a more satisfactory feed for the man who feeds 2 or more carloads of cattle per year than for the farmer who feeds only 15 to 25 head, unless the feeding of relatively large amounts *of silage is made possible by limiting the grain ration to considerably* less than a full feed.

Feeding Silage to Calves. Some feeders who have found corn or sorghum silage a satisfactory feed for mature steers consider it to be too bulky for finishing calves. However, in some respects it is more useful in feeding animals of this age than older cattle for the reason that calves are fed for a much longer time and thus have greater need of variety and succulence in their rations. By starting calves on nearly a full feed of silage, 12 to 15 pounds a head, and adding grain and protein concentrate as the calves grow and attain capacity for more feed, the calves are gradually got up to a full feed with almost no risk of their going off feed or becoming foundered. On most farms the silo is empty by April or May and the change to dry roughage results in an increased consumption of grain at the time of year when the appetite of full-fed cattle is usually slowed down by the advent of hot weather. Should the supply of silage last until the calves are finished, the amount should be reduced to 4 or

5 pounds a day upon the arrival of summer, or on approximately June 1.

The proper amount of silage for calves is a somewhat disputed question. Obviously the amount to feed will depend greatly upon the size and age of the calves and the length of the feeding period. The Illinois station had excellent success feeding 8 pounds of silage and 2 pounds of legume hay per head daily for the first 6 or 7 months and 6 pounds of silage and 2 pounds of hay thereafter. However, in experiments in which different amounts of silage were compared, equally good gains were secured by feeding 16 pounds of silage and 3 pounds of hay during the first 140 days and approximately half these amounts thereafter. The calves fed in this manner maintained their feed consumption and rate of gain much better during the summer than the other lots. Consequently this plan of feeding appears to be satisfactory for calves that are to be carried into late summer and fall.

Calves fed medium or large amounts of silage in the Illinois experiment exhibited much steadier appetites than those fed little or no silage. No signs of scouring were observed in the two lots receiving the larger amounts of silage, whereas the calves in the other lots scoured intermittently during the first half of the experiment but very little thereafter.

Replacement Value of Silage. The introduction of corn silage into a ration affects the consumption of grain and dry roughage with respect to both the amounts eaten per head daily and the amounts consumed per 100 pounds of gain. Experiment station bulletins, mimeographed circulars, and other reports of feeding experiments that have been made to determine the value of corn silage for finishing cattle contain a large amount of data on these points, a few of which have been summarized in Table 181.

Corn silage, because of the wide differences in grain and moisture content, varies in its replacement value in terms of shelled corn and hay. Its replacement value is also affected by the amount of silage fed; large amounts displace somewhat more grain and hay from the daily ration per pound of silage fed than small amounts, but replace less grain and hay per pound of silage than small amounts, with respect to feed required per 100 pounds gain. However, these variations are not so great that they make it impossible to assign corn silage a replacement value that is highly useful for the practical feeder.

By comparing the daily feed consumption and the feed consumption per 100 pounds of gain of more than 60 paired lots of cattle, when only one of each pair was fed silage or when both were fed silage but in

Table 181

REPLACEMENT VALUE OF CORN SILAGE

	Feeds Replaced by 1 Ton of Silage	
	Shelled Corn	Air-Dry Roughage
Indiana Bulletin 235	4.61 bu.	613 lb.
Ohio Bulletin 193	4.43 bu.	588 lb
Author's average of 61 paired lots of steers	4.30 bu.	645 lb.
Average	4.45 bu. or 250 lb.	615 lb.
Correction factor for hybrid corn	+20%	−20%
Adjusted value	*300 lb.*	*494 lb*
Percentage of silage (2,000 lb.)	15%	25%

different amounts, the senior author has determined the average replacement value of a ton of corn silage to be 4.3 bushels of shelled corn and 645 pounds of air-dry roughage. These figures agree closely with 4.6 bushels of corn and 613 pounds of hay reported in Indiana Bulletin 235, and 4.4 bushels of corn and 588 pounds of corn stover and mixed hay given in Ohio Bulletin 193.

Inasmuch as most of the feeding experiments from which these results were derived were carried out many years ago with silage made from open-pollinated corn, which had more stover but fewer ears than our present-day hybrid varieties, it seems wise today to increase the corn and decrease the dry roughage replaced by silage by about 20 per cent. When this is done the average replacement value of corn silage in terms of shelled corn and air-dry roughage is 15 and 25 per cent, respectively. (See Table 181.) Therefore a drove of cattle that is fed 400 pounds of shelled corn, 100 pounds of hay, and 600 pounds of corn silage is receiving the equivalent of 490 pounds of corn and 250 pounds of air-dry roughage, since 15 per cent of the weight of the silage is its shelled-corn equivalent and 25 per cent of its weight is its approximate air-dry roughage value. If the feeding of corn silage is discontinued in this example, the corn and hay should be immediately increased by 90 and 150 pounds, respectively, to keep the cattle on the same level of feeding.

Value of a Dry Roughage with Silage. Although satisfactory results may be expected from a ration consisting of shelled corn, a protein concentrate, and corn silage, feeding experiments indicate that the ration is improved by the addition of a small amount of dry

5 pounds a day upon the arrival of summer, or on approximately June 1.

The proper amount of silage for calves is a somewhat disputed question. Obviously the amount to feed will depend greatly upon the size and age of the calves and the length of the feeding period. The Illinois station had excellent success feeding 8 pounds of silage and 2 pounds of legume hay per head daily for the first 6 or 7 months and 6 pounds of silage and 2 pounds of hay thereafter. However, in experiments in which different amounts of silage were compared, equally good gains were secured by feeding 16 pounds of silage and 3 pounds of hay during the first 140 days and approximately half these amounts thereafter. The calves fed in this manner maintained their feed consumption and rate of gain much better during the summer than the other lots. Consequently this plan of feeding appears to be satisfactory for calves that are to be carried into late summer and fall.

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By comparing the daily feed consumption and the feed consumption per 100 pounds of gain of more than 60 paired lots of cattle, when only one of each pair was fed silage or when both were fed silage but in

material, such as hay or straw. The amount of such roughage eaten is usually only 2 or 3 pounds a day, but it appears to have a noticeable effect upon the rate of gains, especially if the roughage fed is clover or alfalfa hay. These legumes are rich in minerals and vitamins, both of which are likely to be deficient in a ration in which corn or sorghum silage is the only roughage. Inasmuch as calves have greater need for minerals and vitamins than do older animals, their response to the addition of a legume hay is usually greater. If no legume hay is available, calcium should be supplied in the form of ground limestone.

If the dry roughage fed is straw or average- to low-grade hay, it may be kept before the cattle with little danger of their eating enough to interfere with their consumption of grain or silage. However, if it is legume hay of good quality it should be fed at the rate of 2 or 3 pounds a head, preferably about noon after the morning's feed of grain and silage has been eaten. Table 182 summarizes the results of several tests which demonstrate the value of small amounts of dry roughage.

Table 182

THE VALUE OF A DRY ROUGHAGE WITH A HEAVY SILAGE RATION

Number of Trials Averaged	Rations Compared	Daily Gain	Feed per Pound Gain				
			Shelled Corn	C.S.M.	Legume Hay	Oat Straw	Corn Silage
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
4 (Two-year-olds) (Indiana Experiment Station)	Shelled Corn, Cottonseed Meal, Corn Silage	2.37	5.97	1.14	....	....	12.66
	and Shelled Corn, Cottonseed Meal, Clover Hay, Corn Silage	2.45	5.74	1.12	1.41	....	11.16
3 (Two-year-olds) (Indiana Experiment Station)	Shelled Corn, Cottonseed Meal, Clover Hay, Corn Silage	2.41	5.67	1.16	1.09	....	10.37
	and Shelled Corn, Cottonseed Meal, Oat Straw, *Corn Silage*	2.45	5.67	1.15	....	.56	10.59
2 (Calves) (Illinois Experiment Station)	Shelled Corn, Cottonseed Meal, Corn Silage	2.03	5.09	1.02	....	....	7.49
	and Shelled Corn, Cottonseed Meal Alfalfa Hay, Corn Silage	2.20	4.79	.96	1.53	....	4.64

The Feeding of Moldy and Frozen Silage. Seldom does any trouble result from feeding small quantities of moldy silage to beef cattle. All roughage consumed by cattle goes first to the paunch, where it remains several hours before going into the true stomach. Apparently the process of fermentation that occurs in the paunch destroys or renders harmless the ordinary molds. Moldy grain is another matter and should not be fed.

Spoiled silage has very little feeding value since the fermentation process results in the breaking down of a large amount of the food nutrients. Also, it should be realized that spoiled feed of any sort may harbor not only the harmless molds but deadly toxin-forming organisms as well. The careful feeder will take all reasonable precautions to see that no great amount of moldy silage is fed, though some feeders mix moldy silage with larger amounts of high-quality silage.

During extremely cold weather a considerable amount of frozen silage is encountered in regions where temperatures drop to 0° or below, especially in silos where little feed is removed each day. This frozen material should be removed from the walls of the silo as soon as it is possible to knock or pry it loose. If the pieces are small and not too numerous they may be piled in the center of the silo after the morning's feed, where they often thaw out before night. With a large quantity of frozen silage, however, or with the temperature much lower than freezing, this method is not practical. Instead, the frozen silage should be piled just outside the silo where it can be carefully watched and fed as soon as it is reasonably well thawed out. If left longer it will become moldy and unfit for use.

The presence of small quantities of frozen silage in the ration is not likely to cause trouble, but the feeding of large amounts of frozen silage is highly inadvisable. Not only is such material unpalatable and difficult for the cattle to eat, but it is likely to cause serious disorders of the digestive tract. Excessive scouring is one of the common after-effects of feeding frozen silage.

The question is often asked as to how long one must wait after filling a silo before it is safe to begin feeding from it. Many successful feeders begin feeding immediately, thus eliminating the top spoilage which occurs with waiting. However, the silage in the upper layer is usually quite warm and the typical mildly acid taste of properly fermented silage is absent; consequently it is not readily consumed by the cattle. Waiting a week or so insures that most of the fermentation has occurred, the silage has cooled off, and cattle will start off on the new and strange—to them, at least—feed with much more relish.

material, such as hay or straw. The amount of such roughage e is usually only 2 or 3 pounds a day, but it appears to have a notice effect upon the rate of gains, especially if the roughage fed is cl or alfalfa hay. These legumes are rich in minerals and vitam both of which are likely to be deficient in a ration in which corn sorghum silage is the only roughage. Inasmuch as calves have gre need for minerals and vitamins than do older animals, their resp to the addition of a legume hay is usually greater. If no legume is available, calcium should be supplied in the form of ground li stone.

If the dry roughage fed is straw or average- to low-grade hay may be kept before the cattle with little danger of their eating eno to interfere with their consumption of grain or silage. However it is legume hay of good quality it should be fed at the rate of 2 3 pounds a head, preferably about noon after the morning's feed grain and silage has been eaten. Table 182 summarizes the res of several tests which demonstrate the value of small amounts dry roughage.

Table 182

THE VALUE OF A DRY ROUGHAGE WITH A HEAVY SILAGE RATION

Number of Trials Averaged	Rations Compared	Daily Gain	Feed per Pound Gain				
			Shelled Corn	C.S.M.	Legume Hay	Oat Straw	C S
		lbs.	lbs.	lbs.	lbs.	lbs.	
4 (Two-year-olds)	Shelled Corn, Cottonseed Meal, Corn Silage	2.37	5.97	1.14	....	...	[illegible]
	and						
(Indiana Experiment Station)	Shelled Corn, Cottonseed Meal, Clover Hay, Corn Silage	2.45	5.74	1.12	1.41	....	[illegible]
3 (Two-year-olds)	Shelled Corn, Cottonseed Meal, Clover Hay, Corn Silage	2.41	5.67	1.16	1.09	...	[illegible]
	and						
(Indiana Experiment Station)	Shelled Corn, Cottonseed Meal Oat Straw, Corn Silage	2.45	5.67	1.15	....	.56	[illegible]
2 (Calves)	Shelled Corn, Cottonseed Meal, Corn Silage	2.03	5.09	1.02	....	...	[illegible]
	and						
(Illinois Experiment Station)	Shelled Corn, Cottonseed Meal, Alfalfa Hay, Corn Silage	2.22	4.79	.96	1.23	....	[illegible]

The Feeding of Moldy and Frozen Silage. Seldom does any trouble result from feeding small quantities of moldy silage to beef cattle. All roughage consumed by cattle goes first to the paunch, where it remains several hours before going into the true stomach. Apparently the process of fermentation that occurs in the paunch destroys or renders harmless the ordinary molds. Moldy grain is another matter and should not be fed.

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Table 183

EFFECT OF CORN SILAGE UPON PRODUCTION OF PORK*

(Total of 3 Lots)†	Silage-Fed Cattle (20 Steers)	Dry-Fed Cattle (21 Steers)
Total gains of hogs	1,445 lb.	1,670 lb
Average daily gain per pig	1.027	1.187
Pork produced per steer	72.25	79.52
Total corn fed cattle (including corn in silage)	929 bu.	934 bu.
Pork produced per bushel corn fed cattle	1.55 lb.	1.79 lb.

* *Ohio Bulletin 193.*

† A small amount of tankage was fed to the hogs in both silage and non-silage lots.

Effect of Silage upon Swine Gains. Since the use of corn or sorghum silage results in a decrease in the consumption of grain as such, swine gains are naturally smaller after silage-fed cattle than after cattle fed dry roughage. Apparently the corn present in the silage is so thoroughly digested that little of it is available in the feces for swine feed. Tests conducted with mature dairy cows show that less than 10 per cent of the grain in silage is voided in the manure, whereas 22 to 35 per cent of the shelled corn fed may be excreted by such cattle. The same phenomenon occurs with steers, as is verified by data such as those in Table 183.

Effect of Silage upon Shipping and Sale. Some feeders hold the opinion that silage-fed cattle suffer much greater shrinkage between feed lot and market than cattle fed dry roughage. For this reason they sometimes remove the silage from the ration a few days before shipping and supply a dry roughage in its place. However, records kept of the actual shrinkage suffered by silage-fed and non-silage-fed cattle, respectively, show that this practice is unwise because the silage-fed cattle had in reality a smaller shrinkage than hay-fed cattle. Although it was true that silage-fed cattle in some cases lost more weight while in transit, they were more inclined to take on a greater "fill" after they were unloaded. Silage cattle have a reputation at the market for being unusually good "drinkers." Whereas this kind of fame probably does not work to their advantage when it comes to selling price, it does indicate that their owners get good weights.

In former years when dry roughage was the orthodox feed for finishing cattle, the few silage-fed steers received at the market were regarded with considerable suspicion. It was feared that they would resemble grass-fattened cattle in having a low dressing percentage and dark-colored flesh of rather poor quality. Comparisons of the

carcasses of such cattle with those of animals finished on dry roughage disclosed no important differences in amount or quality of finish that could be traced to silage. As the number of silage-finished cattle increased, packers and shippers bought them as a matter of course and frequently found them superior to any dry-roughage-fed cattle included in their purchases. Naturally the tendency to discriminate against such cattle soon disappeared and they were bought on the basis of their actual worth.

At the present time a large percentage of grain-fed steers received at Chicago and other large livestock markets have been fed silage. Seldom does a buyer stop to inquire whether a given drove has had silage or not. If the cattle show unusual size of paunch and an indication of a rather large "fill," he may suspect that they have been fed silage, but whether this or some other factor is the cause of their condition makes little difference to him. He estimates their dressing percentage, judges their worth on the rail, and forthwith states the price he will pay for them.

Effect of Silage upon Profits. No one ration or plan of cattle feeding is more profitable than another under all conditions. However, if an attempt were made to classify rations on the basis of the net profit realized from their methodical use over a period of years, those containing moderate and fairly liberal amounts of silage probably would be at the top. The reason for this economy is probably that cattle fed silage have a smaller feed bill than those fed only dry roughage. Then, as a rule, silage-fed cattle develop more uniformly and a smaller percentage are affected by founder and bloat. Because of their attractive appearance when marketed they frequently sell higher than cattle of similar quality that have been fed for the same length of time, but not fed rations containing corn silage. Table 184 gives data which show that silage-fed cattle are not penalized on the market.

It is not without significance that nearly all Corn Belt experiment stations have for many years used a ration containing corn silage as a check or standard with which new and little-tried feed combinations are compared. This practice is the result of obtaining better returns from feeding corn silage than from feeding dry roughages in literally scores of experiments made over a period of more than 50 years. Typical of such returns are those of the Illinois station given in Table 185. In all ten of the Illinois tests better returns per head were obtained from cattle fed corn silage than from those fed the same feeds but with the silage omitted.

Poisonous Gas in Newly-Filled Silos. It has been known for years that gases collect above the silage in tower silos during or immediately

Table 184

COMPARISON OF SELLING PRICES OF SILAGE AND NON-SILAGE CATTLE*

Year	Selling Price per cwt. of Finished Cattle						Lot Bringing Highest Price
	Silage Cattle			Non-silage Cattle			
	Number of Lots	Range	Average	Number of Lots	Range	Average	
1906–07.. . .	1	. ...	$5 30	1	. ...	$5 45	Non-silage
1907–08	2	$6 00–6.70	6 35	2	$5.95–6 70	6 33	Equal
1908–09..... .	2	6 80–6 90	6 85	2	6.55–6 75	6 65	Silage
1909–10	3	7 20–7 60	7 35	1	... .	7 30	Silage
1910–11	3	5 75–5 95	5 85	1	.. ... .	5 85	Silage
1911–12	3	8 10–8 35	8 23	1	....	8 25	Silage
1912–13.......	2	7 75 7 85	7 80	1	....	7 90	Non silage
1913–14	2	8 40–8 70	8 55	2	8.50–8 60	8 55	Silage
1914–15.. ..	2	8 20 8 35	8 28	2	8.25–8 30	8 28	Silage
1915–16 ...	2	8 70–8 75	8 73	2	8 65–8 65	8 65	Silage
1916–17	2	12 00–12 00	12 00	2	11.75–11.75	11 75	Silage
11 years	24	....	$7.75	17	....	$7.72	8 Silage 2 Non silage 1 Equal

* Indiana Experiment Station, Bulletins on Steer Feeding.

after filling. These gases, mostly carbon dioxide, have not been found to be particularly dangerous. Within the last few years, however, a more dangerous situation has been recognized and numerous fatalities have been reported among men working in silos, especially in the main corn-growing states The toxic gas has been identified as nitrogen dioxide. The gas seems to develop most readily in corn silage grown in years when drought damages corn that has had heavy applications of nitrogen fertilizer. Under these conditions the plants evidently absorb more nitrates from the soil than they are able to use. The excess nitrate is released during the ensilaging process and, through a series of chemical reactions, is changed into nitrogen dioxide gas. Symptoms of "silo fillers' disease" are severe coughing and burning or choking pains in the throat and chest. The condition usually attacks as a person enters a silo during filling or within 48 hours after filling. A physician should be consulted if such symptoms occur.

Scientists from the United States Department of Agriculture recommend these safety precautions in filling all tower silos:

1. Run the blower for 10 minutes before going into a partly filled silo. Always keep the blower running while you are inside.
2. Be alert for irritating odors. Nitrogen dioxide is heavier than air and collects near the surface of the silage. The gas tends to settle in the silo chute and around the base of the silo.
3. Watch for yellowish brown fumes—they are a sign of nitrogen dioxide gas. If the silo is dark, use a flashlight so that you can see.
4. Keep children and animals out of the silo and away from it during filling.
5. After the silo is filled, wait at least a week before going inside if the blower cannot be operated. Don't let children stay near the silo. *If necessary, use a temporary fence to help keep them safe.*

Table 185

Effect of Silage upon Profits Realized from Feeding Cattle*

Year	Age of Cattle	Selling Price per Cwt.		Return per Head Over Feed Costs		Return per Bushel of Corn Fed	
		Fed Silage	No Silage	Fed Silage	No Silage	Fed Silage	No Silage
1912–13	Calves	$8 70	$8.50	$10 33	$6 84	$0 73	$0 61
1913–14	Calves	10 00	10 00	12 13	8 86	0 86	0.78
1928–29	Calves	15 90	15 65	18 73	8 17	1 15	0 94
1929–30	Calves	10.30	10.60	−20.85	−22 35	0.26	0.28
1931–32	Calves	8.35	8.15	22 03	19 96	0.71	0.68
1937–38	Calves	11 15	10 75	20 88	13 08	0 93	0.82
1938–39	Calves	9 60	9 15	11 85	6 61	0 65	0 59
Average		10 59	10 40	10 73	5 88	0 76	0 67
1910–11	2-year-olds	5 95	6.10	4 24	3 85	0 53	0.49
1911–12	2-year-olds	7 45	7 55	11 63	7 66	0 91	0 77
1941–42	2-year-olds	12 60	12 25	21 21	16 42	1 14	1.11
Average		8 67	8 63	12 36	9 31	0 86	0.79

* Illinois Experiment Station Mimeo. Reports of Cattle-Feeding Experiments.

chapter 21 COMPARISON OF VARIOUS SILAGES FOR BEEF CATTLE

To the man who lives in the older cattle feeding area, namely, the Corn Belt, the term "silage" generally means ensilaged Indian corn. However, outside the region where corn can be successfully grown, various other crops are used for silage purposes. Since the tonnage of corn silage made and fed greatly exceeds that made from all other silage materials, it will be convenient to compare these other kinds of silage with corn silage as a standard.

Corn Silage as the Principal Feed for Finishing Cattle. A full feed of corn silage supplemented with an appropriate amount of protein concentrate causes cattle to lay on fat, as was discussed under the subject of limited grain rations in Chapter 15. If the silage is made from high-yielding corn and is harvested at the proper stage of maturity, thin cattle make a noticeable improvement in condition during the first half of the feeding period on silage alone, with no additional corn. Usually it is important to feed as little as 2 or 3 pounds of hay per day, or no hay at all, in order to obtain the consumption of as much silage as possible. This, of course, means that 1 to 2 pounds of protein concentrate must be fed daily, as well as a mineral supplement

Cattle with sufficient quality to sell near the top of the market, if they have the necessary finish, usually return more profit if they are fed a full feed of corn or sorghum grain during at least the last half of the feeding period, but cattle of medium grade sometimes show the greatest net return if they are continued on a heavy silage ration until they are marketed. Two-year-old or long yearling steers are more satisfactory for such a plan of feeding than younger cattle, since they attain a satisfactory finish for their grade in a shorter time. Gains made by cattle on limited grain rations are relatively low after 120–130 days.

Calves, because of their growth tendencies, cannot attain a satisfactory finish on silage alone. However, corn silage may constitute

Table 186

THE VALUE OF CORN SILAGE AS THE PRINCIPAL FEED FOR FINISHING CATTLE

	Ohio* Yearling Steers		Illinois† Calves	Indiana‡ Calves	
	1928-29	1929-30	1951-52	1949-50	1950-51
Yield of corn, bu.	48	...	75	70	70
Yield of silage, tons	...	...	15	15	14
Days fed	174	177	126	112	147
Ration fed, lb.					
Corn silage	47.4	49.4	26.6	31 0	37.0
Supplement	2 0	2 0	3.4	3.5	3.5
Legume hay	1.2	2 8	...	..	...
Av. initial wt., lb.	622.0	662 0	320 0	478.0	481 0
Av. final wt., lb.	971.0	1,036 0	502 0	721 0	806.0
Av. daily gain, lb.	2 01	2.11	2 70	2.18	2 21
Supplement fed	C.S.M.	C.S.M.	S B O.M. 1 25 lb.	S.B.O M.	2 25 lb
			Shelled corn 2 00	Molasses feed	1 0
			Minerals 0 11	Bonemeal	0 18
				Iod. salt	0.06
			3.36 lb.	Vit. concentrate	0 01
					3 50 lb

* Ohio Bimonthly Bulletin 151.
† Illinois Mimeographed Report, 1952.
‡ Indiana Mimeographed Reports AH 47 and 59.

the principal item of their ration for the first one-third or two-fifths of a feeding period that is to extend over 9 or 10 months. Daily gains of 1¾ or even 2 pounds a day may be obtained if 1½ to 2 pounds of protein concentrate are fed and the silage is of excellent quality. Attention is called to the excellent gains made by calves at the Indiana Experiment Station, which were fed a full feed of corn silage and 3½ pounds of a fortified supplement composed of soybean oil meal, molasses, various minerals, and a vitamin A concentrate (see Table 186), and to those made in the Illinois test, reported in the same table, where a simpler concentrate was fed.

At What Stage Should Corn Be Ensilaged? The best quality of silage is produced by cutting the corn when the kernels have hardened to the point at which their interior is of a stiff dough-like consistency but a large portion of the stalk and most of the leaves are still green. Silage made from immature corn is likely to be sour and "sloppy." Moreover, the cutting of very green corn entails a waste, since the *total amount of food nutrients in the corn plant continues to increase* until the ears are fully mature. On the other hand, corn that is almost ripe is made into silage with considerable difficulty. Unless sufficient water is added to soften the dry stalks and leaves to permit their being packed so firmly that all air is excluded, silage made from over-ripe corn is very likely to mold.

A measured area of corn ensilaged in the roasting-ear stage from August 12 to 14 at the Ohio station proved to be of much lower feeding value than an equal acreage ensilaged September 5 to 8, when the corn was well dented. Samples taken of the corn at the time of harvest showed that 17 per cent less dry matter per acre was obtained from the early-harvested corn. Moreover, considerable juice leached out of the silo after this corn was stored. As a result only 755 pounds of gain per acre were obtained from the immature silage compared with 940 pounds per acre from the well-dented corn. The cattle fed the immature silage were not so well finished and were valued 25 cents a hundred lower than the steers fed the riper silage.[1]

Table 187 shows data from an Illinois study in which the effect of stage of maturity and dry-matter content are related to ear and leaf content of a ton of corn forage.

An Oklahoma Extension Service[2] agronomist makes the following recommendations as to the most desirable time to cut forage crops for silage:

Corn: When grain is in the soft-dough stage.
Sorghums: When grain is in the dough stage.
Alfalfa: One-fourth to one-half bloom stage.
Sweet clover: Early bloom stage.
Other clovers: One-fourth to one-half bloom stage.
Cereals: Soft-dough to hard-dough stage.
Vetch: Full bloom stage.
Sudan: Early heading stage.
Grasses: Bloom to early heading stage.

Obviously, weather conditions often determine the time of making silage. During periods of severe drought it may happen that the corn must go into the silo with the base of the stalk and the lower leaves brown and dry and the ear and upper portion of the stalk still green. Although first-class silage cannot be made under such conditions, to delay longer would permit the drying up of the entire plant.

Effect of Corn Yields on Value of Silage. It would seem that silage made from hybrid corn yielding 80 to 100 bushels per acre would have a much higher feeding value per ton than the silage made from open-pollinated corn that yielded considerably less. Also it would seem that silage made during a dry year would have a low feeding value because of the low yield of grain. However, corn yields have a much greater effect upon the yield per acre of silage than upon

[1] Ohio Bimonthly Bulletin 223.
[2] Oklahoma Extension Circular 620.

Table 187

EAR-CORN CONTENT AND LEAF-STALK HAY-EQUIVALENT IN ONE TON OF CORN FORAGE AT VARIOUS STAGES OF DEVELOPMENT*

Dry-Matter *Content* of Forage† (%)	Ears‡ (bu.)	Leaves *and* Stalks§ (lb.)	Dry-Matter *Content* of Forage† (%)	Ears‡ (bu)	Leaves *and* Stalks§ (lb.)
15	0.2	308	24	3.1	312
16	0 5	309	25	3 4	312
17	0.8	309	26	3.8	313
18	1.1	309	27	4.1	313
19	1.5	310	28	4.4	314
20	1.8	310	29	4 8	314
21	2.1	311	30	5.1	315
22	2.5	311	31	5 4	315
23	2.8	312	32	5.7	315

* Illinois Bulletin 576, 1954.

† *In the absence of dry-matter determinations, dry-matter content of forage may* be estimated on the basis of stage of development, as follows:

Ears beginning to form	15%	Early dent	25%
Kernels forming	17	Well dented	28
Early milk	20	Kernels hardening, most leaves green	30
Late milk	23	Kernels hardening, fewer leaves green	32

‡ On the basis of 15 per cent moisture, 70 pounds of ears per bushel.

§ Hay-equivalent value, on the basis of 15 per cent moisture.

the feeding value per ton. (See Table 188.) *Although the yields of* both dry corn and silage at the Illinois station have varied widely from year to year, the corn content per ton of silage has remained rather constant, especially for the hybrid varieties of corn.

Varieties of Corn for Silage. Although certain corn hybrids yield an enormous tonnage of silage owing to their rank growing tendencies, such silage is not especially valuable for finishing cattle because of the low percentage of grain present. Silage made from such "silage hybrids" may be very well suited to dairy cattle that need a highly succulent ration but the ordinary varieties of corn, which produce a large yield of sound grain, make a much more satisfactory silage for finishing cattle. Not only does it require the addition of smaller amounts of concentrates when fed to animals that are being finished, but it also produces more growth and development when fed to heifers and stockers that are being carried through the winter.

Table 188

EFFECT OF YIELD OF CORN UPON CORN CONTENT OF SILAGE*

	Yield of Corn per Acre, bushels (14% Moisture)	Yield of Silage Corn per Acre, tons	Corn per Ton of Silage, bushels
1. Open-pollinated corn			
1925	72.9	8.84	8.24
1926	44.7	8.71	5.13
1927	68.5	14.73	4.65
1928	78.9	12.62	6.25
1929	48.3	9.70	4.98
Average	62.7	10.92	5.85
2. Hybrid corn			
1946	92.2	13.29	6.64
1947	66.9	10.51	6.37
1948	106.5	16.68	6 39
1949	91.0	12.63	7.20
1950	52.0	9.35	5.38
Average	81.7	12.49	6.40
Percentage of increase	30.3	14.4	9.4
3. Dry years			
1934 (dry year)	35.0	6.38	5.49
1935 (normal rainfall)	57.1	10.25	5.57
1936 (dry year)	33 9	7.51	4.50

* Illinois Station, unpublished data.

Value of Frosted Corn for Silage. The silo offers the best possible way to utilize corn that has been frosted before the ears are mature. If put into the silo immediately after the frost, the silage has almost the same feeding value as it would had the corn been ensilaged just before the frost occurred. If, however, the corn is allowed to stand until the leaves are withered and dry, many of the leaves will be blown away and the quality of the silage will be greatly reduced. A heavy rain on frosted corn also causes much damage by leaching out a considerable amount of the soluble food nutrients. It is usually necessary to add some water to frosted corn to make it pack well in the silo

Sorghum Silage. The various forage sorghums, such as Tracy, Sart, and Atlas sorgo, are quite satisfactory silage crops and are grown extensively for this purpose in the semi-arid regions of the Southwest. Hybrid forage sorghums give promise of far surpassing

those just mentioned. Yields of silage per acre are usually larger for forage sorghums than for corn, especially when the rainfall is deficient during the growing season. Should early frosts occur, less damage is suffered by the sorghums than by corn, because the leaves are not so easily lost.

Silage made from the forage sorghums is somewhat lower than corn silage in both protein and fat and is higher in crude fiber. With only a few exceptions, feeding experiments in which both corn and sorghum silages have been used point to the superiority of corn silage. Although the difference is not large it is sufficient to indicate that corn is the more valuable silage crop in areas where corn can be grown, except during unusually dry weather. The added yield, as silage, of sorghums makes an acre of forage sorghum equal to an acre of corn in areas where sorghum is more adapted than corn.

Several varieties of grain sorghum are grown for silage in the arid Southwest but the variety most popular in the Corn Belt is still Atlas sorgo. This forage crop has yielded twice the tonnage of corn silage in Kansas and Nebraska during extremely dry years and 50 per cent more in Illinois during years of average rainfall. The silage is of finer texture and slightly more palatable than corn silage, but it

Table 189

COMPARISON OF CORN AND SORGHUM SILAGES FOR FINISHING CATTLE

	Kentucky Bulletin 233 Average of 3 Trials with 2-Year-Old Steers		Oklahoma Bulletin 139 Calves, 185 Days				Illinois Exp. Sta. Unpublished Data. 1938–1939 Calves, 150 Days	
	Corn Silage, pounds	Sorghum Silage (Red Top), pounds	Corn Silage, pounds	Cane Silage, pounds	Kafir Silage, pounds	Darso Silage, pounds	Corn Silage, pounds	*Atlas* Sorgo Silage, pounds
Average daily gain	2.05	1.81	2.08	1.99	1.98	2.05	2.18	2.08
Feed per cwt. gain								
Shelled corn	226*	240*	541	565	569	549	338	300
Silage	2,158	2,469	630	658	662	639	380	393
Protein conc.	182	210	50	52	52	50	54	59
Dry roughage	132	168	50	52	52	50	92	96
Relative amount of pork per head	...	...	100	62	102	37	100	80
Average yield per acre, tons	10.4	16.2					10.6	17.8

* Corn fed during only last part of trials.

possesses less feeding value per ton, probably because many of its small, hard seeds are swallowed whole and are not digested. Apparently Atlas sorgo silage compares less favorably with corn silage for wintering stocker calves than it does as a roughage for cattle that are given a full feed of grain. However, for either of these classes of cattle it usually surpasses corn silage when the returns are expressed on an acre basis. Table 189 gives data on comparative feeding value of corn and various older varieties of forage sorghums. Experimental data on the feeding value of the new higher-yielding hybrid forage sorghums are not available, but observation would indicate that the large, soft seeds they contain improve their feeding value.

Hay-Crop Silage. This term refers to silage made from alfalfa, clover, brome grass, timothy, and other crops that are ordinarily grown, either in pure stands or in mixtures, for hay. Other designations for this kind of silage are legume-grass silage, grass silage, or merely alfalfa, red clover, or brome-grass silage, if one of these species comprises most or all of the freshly cut forage. Whether it is better to harvest these crops as silage rather than cut them for hay depends upon a number of factors. In general, the advantages of ensilaging over harvesting for hay are as follows:

1. The crop is less seriously damaged by rains encountered during the harvest period.
2. A much smaller percentage of the leaves is lost; leaves are the most valuable portion of the forage.
3. Considerably more protein is obtained per acre. This protein results largely from the saving of more leaves, but it is partly due to the fact that some crops, principally the grasses, are cut for silage earlier than for hay; consequently the protein content is higher.
4. The carotene present at the time of cutting is preserved much better in silage than in hay.
5. Silage is somewhat more palatable and digestible than hay; consequently it may constitute a larger percentage of the ration of finishing cattle without seriously reducing the rate of gain.
6. Silage is more suited to mechanized feeding operations.

The principal disadvantage of using legumes and grasses for silage rather than for hay is the higher cost of harvesting. This added cost is represented chiefly by the expensive field harvesters, the silo-filling equipment, and the silos required for storage. The use of surface or horizontal silos reduces the cost considerably. If, by chance, silage-

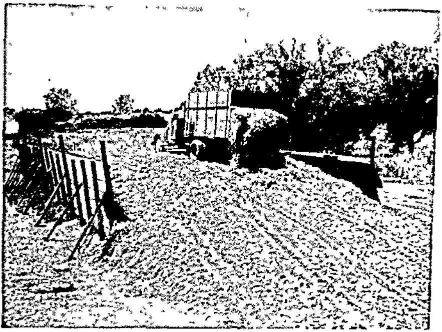


FIG. 81. Filling a bunker silo, using a self-unloading truck. Proper packing and leveling reduce spoilage losses. (John Deere, Moline, Illinois.)

making equipment is already available for making corn silage it can, of course, be used for making hay silage with little additional expense.

MAKING HAY-CROP SILAGE. Much more care and judgment must be exercised in making hay-crop silage than in making corn silage, if silage of high quality is to be produced. Cutting the forage when it is either too ripe or too green, allowing it to lie in the swath or windrow too long before it is ensilaged, or failing to add the proper amount of preservative to the cut forage is likely to result in unpalatable silage of low feeding value.

Two types of field cutters are available. One type mows and chops the forage in a single operation and the other type picks up the forage from the windrow after it has been cut with a mower and windrowed with a side-delivery rake. If the former type of harvester is used, the forage should be cut when somewhat riper than is advisable for the latter type, since little moisture is lost by the forage during handling. Cutting the forage with this harvester when it is too green results in a wet, "sloppy" silage, which is unpalatable and of low feeding value because of its high moisture content. If the moisture content is too high (75 to 82 per cent), a considerable percentage of the feed value is lost in the juices that seep through the doors of

the silo, and perhaps through the walls as well, if the silo is not well constructed. Free water in a silo, whether or not seepage occurs, is to be avoided since its presence is highly destructive to the silo, first through the enormous hydrostatic pressure exerted on the walls, and second through the constant corrosive action of the silage acids on the walls of concrete and metal silos.

Most authorities agree that the best quality of hay-crop silage is made from forage that contains from 65 to 70 per cent moisture or 30 to 35 per cent dry matter at the time it is put into the silo. If it is desired to fill the silo when the moisture content is higher, the forage should be allowed to lie in the swath or windrow to permit the evaporation of the excess water. Normally on a warm, sunny day the moisture content drops 3 or 4 per cent between the time the forage is cut and the time it is stored in the silo, when the forage is mowed, raked, and chopped with a field cutter from the windrow without waiting for it to dry. Mowed forage, lying in the swath, loses approximately 5 per cent moisture per hour on a sunny day.

The place of preservatives in making silage is discussed in Chapter 20.

Wilted Grass Silage. There is much evidence that a preservative is not needed if the moisture content of the forage is such as to favor the action of the acid-forming bacteria and retard the development of those which give rise to disagreeable flavors and odors. This method of making hay-crop silage is called the "wilting" method. It was first developed and described by Professor J. B. Shepherd of the Bureau of Dairy Industry, United States Department of Agriculture,[3] who lists the following steps as highly important in making grass silage of good quality:

1. Silos should be airtight and have smooth walls.
2. Wilt the crop slightly. When it is put in the silo the average moisture content should not be higher than 68 per cent or lower than 60 per cent. Scattered loads can have as much as 70 per cent moisture without producing undesirable fermentation and odors, or they can have as little as 55 per cent moisture if such loads are not close to the top of the silo. If a trench silo is used, none of the crop should contain less than 60 per cent moisture. The time required to wilt the crop to the desired moisture level may be only 1 or 2 hours on good drying days, or it may be 2 or 3 days during rainy weather.
3. Set the cutter for ¼-inch cut. This is a *must*, to insure close packing in order to exclude the air.

[3] Mimeographed Circular BDIM-Inf-38, Bureau of Dairy Industry.

4. Distribute the silage evenly during filling and tramp the top third of the silage thoroughly.

5. Put 4 to 6 feet of heavy unwilted silage on top of the wilted silage to insure rapid settling and to keep out the air.

6. Level off the top layer of silage and keep it well tramped near the wall while the silage is settling.

Feeding Value of Hay-Crop Silage. Several experiments have been carried out to compare the feeding value of silage made from grasses and legumes with that of hay made from the same field and also with corn silage grown and harvested the same year. The most extensive tests thus far reported are those made at the Michigan and Pennsylvania stations. At each station three lots of cattle were fed to compare corn silage, alfalfa silage, and alfalfa hay, respectively. At the Pennsylvania station all lots of cattle were fed the same amounts of corn-and-cob meal, whereas the silages and hay were fed according to appetite. In the Michigan tests no grain was fed to the corn-silage lots during the first half of the test, and about one-third of a full feed during the last half. Grain was fed to the legume-hay and silage lots in such amounts that these cattle would gain as much as those fed corn silage. The results of these two series of experiments are given in Table 190.

The relative value of silage made from alfalfa or other legume crop and corn silage is well stated by Professor G. A. Branaman of Michigan State University who, in discussing the results of the Michigan feeding experiments, said:

> More than one pound of grain per day per hundred pounds of steer weight *must be added to a legume hay or a legume silage ration in order to produce* gain and finish equivalent to that obtained when steers are full-fed well-eared corn silage and hay, balanced for protein with a protein concentrate.[4]

Miscellaneous Silage Materials. Almost any green material can be ensilaged successfully if it is packed in a well-built silo so tightly that no air pockets remain, and if sufficient carbohydrate material is present to promote the processes of fermentation, which begin as soon as the material is cut. Naturally, some crops are better suited for silage purposes than others. In addition to having a sufficiently high carbohydrate content to produce enough organic acids to arrest the action of putrefying bacteria before they have caused extensive decomposition, a good silage material must be of such physical texture as to produce an abundance of fine particles, which insure close packing. All plants that have an abundance of leaves in proportion to

[4] Michigan Quarterly Bulletin, Vol 23, No 2.

Table 190

COMPARISON OF CORN SILAGE, LEGUME SILAGE AND LEGUME HAY FOR FINISHING CATTLE

	Pennsylvania Bulletin 410 (Average 3 Trials)			Illinois Mimeo. Report, May, 1942 (1 Trial)			Michigan Quarterly Bulletin Vols. 22–25 (Average 4 Trials)		
	Corn Silage	Alfalfa Silage	Alfalfa Hay	Corn Silage	Alfalfa Silage	Alfalfa Hay	Corn Silage	Alfalfa* Silage	Alfalfa* Hay
Av. initial wt., lb.	627	627	630	852	854	852	491	493	488
Av. daily gain	2.18	2.15	2.06	2.87	2.55	2.45	1.81	1.93	1.81
Av. daily ration									
Corn	12 6†	12.6†	12.6†	16.3	15.5	16.5	2.0‡	9.2	9 2
Protein conc.	1.5	...	...	2 3	1 0	1.0	1.6	1.0§	1 0§
Silage	15 1	20.1	...	22 0	21.7	...	28.0	25.0	...
Legume hay	...	...	8.3	2 0	2.0	6.8	2.0	...	9.5
Feed eaten per cwt. gain									
Shelled corn	581†	586†	609†	668	610	671	111	473	506
Protein conc.	68	...	...	80	39	41	87	9	10
Silage	688	938	. .	766	853	...	1,532	1,293	...
Alfalfa hay	...	..	399	70	79	279	136	...	504
Feed cost per cwt. gain	$8.76	$8.62	$9 02	$11.35	$11 23	$11.39	$7.82	$9.17	$9 63
Selling price per cwt.	$8.95	$8.92	$8.95	$12 60	$12 00	$12 25	$9 90	$10 07	$9 91
Dressing percentage	60.3	60 0	59.8	59 3	59.5	59.4	...	...	...

* A mixture of alfalfa and red clover fed in two trials

† Corn-and-cob meal fed in Pennsylvania trials.

‡ Average for entire period but fed during only last half.

§ Average for last 30 to 60 days, during which time it was fed.

the amount of coarse, woody stems are good silage materials in this respect. A silage crop should also produce a heavy yield per acre. Otherwise the expense of cutting, the time consumed in hauling, and the land rental are so great that the cost of making the silage is abnormally high.

Few of the silages to be discussed have been used extensively in either practical or experimental beef cattle feeding. However, their yield and physical and chemical properties are such as to make them suitable silage crops for those regions where they can be successfully grown.

SUDAN GRASS. Sudan grass belongs to the same group of plants as the grain sorghums. It differs from the sorghums principally in being of finer texture and in having a comparatively light yield of seed. When seeded in rows or broadcast in fertile soil it grows to a height of 6 to 8 feet and yields an enormous tonnage of green forage per acre. Sudan grass intended for silage should be planted in rows because this encourages a better development of heads and leaves and a greater

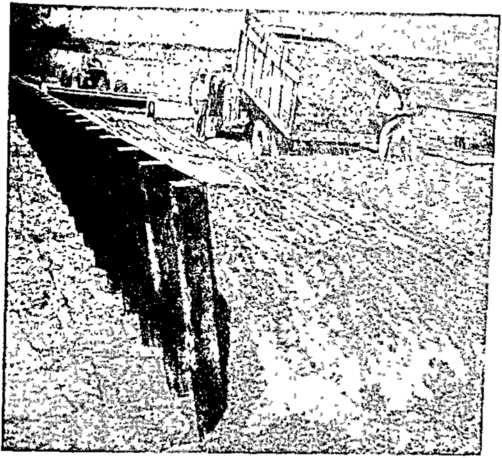


FIG. 82. One method of adding ground shelled corn as a preservative to direct-cut alfalfa. (University of Illinois)

production of seed. Cutting should be done when the seeds are in the *dough stage, although very good silage can be made at almost any* stage of maturity. In the southern states where the growing season is long, both the first and second growths of Sudan grass are available for silage.

One-half of a small field sown to sweet Sudan grass at the Illinois station produced 14.2 tons of silage forage per acre while the other half produced 11.8 tons of corn silage. In a feeding test made with these silages, yearling steers being roughed through the winter gained at the rate of 1.07 pounds daily during the 69 days when Sudan grass was fed, and at the rate of 1.16 pounds during the following 75 days when they were fed corn silage.[5] No significant difference was observed in the palatability of the two silages. Seeding soybeans in conjunction with Sudan grass is a practice which is to be highly recommended

[5] *Illinois Mimeographed Report*, 1949.

because both the yield and protein content of the silage are thereby increased.

OAT AND PEA SILAGE. A mixture of oats and field peas is often grown for forage purposes in the northern part of the United States and in Canada. If the supply of such forage proves to be greater than is needed for pasture its successful harvest is often a perplexing problem, since oats and peas do not usually mature at exactly the same time. The silo offers a satisfactory way of harvesting such a crop. The carbohydrates of the oats insure the successful preservation of the pea vines which, if ensilaged alone, would be likely to spoil because of their high protein content. Silage made from oats and peas is both a palatable and nutritious feed for beef cattle, as shown by Table 191.

Table 191

OAT AND PEA SILAGE FOR FINISHING CATTLE*

Full Feed of Grain plus:	Prairie Hay	Oat and Pea Silage Prairie Hay	Sunflower Silage Pra rie Hay
Daily gain	1.79 lb.	2 48 lb.	2.06 lb.
Feed per lb. gain			
Grain mixture	5.87	4.06	5.49
Hay	9.24	0.96	1.15
Silage	..	13.24	15.00
Linseed meal	0.55	0.40	0.48

* University of Alberta, Canada. Mimeographed Report of Cattle Feeding Trials, 1922

OAT SILAGE. Oats are very generally grown throughout the country. However, they seldom return a satisfactory profit to the farmer because of their low yield and low market price. Their yield is often greatly reduced by the sudden advent of hot, dry weather a few days before they are ripe enough to cut. This hazard can be avoided, in part at least, by cutting the oats while they are still green and making them into silage. Oats that are to be ensilaged should be cut when the kernels are in the dough stage.

In the northern and northwestern states, where oats are grown much more successfully than corn, oat silage may well take the place of corn silage in beef cattle rations. Extensive tests at the Illinois station, as well as other stations, show that oat and other cereal silages used in finishing rations have a feeding value comparable to that of hay-crop silage but somewhat below corn silage. (See Table 192.)

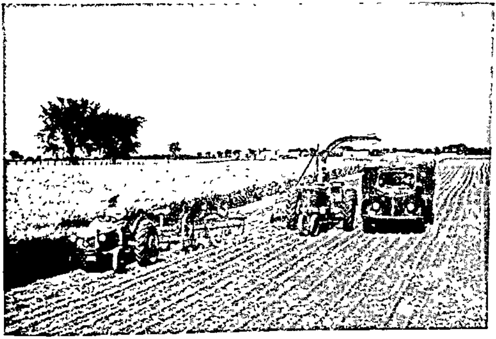


FIG. 83. The income from an oat crop, when harvested as silage and fed to stockers or cows, may easily be doubled as compared with the usual harvesting methods. (University of Illinois.)

Table 192

OAT SILAGE FOR FINISHING CATTLE

	Two-Year-Old Steers				Yearlings	
	University of Alberta, Canada* (Av of 3 Trials)		Illinois Experiment Station†		Illinois Experiment Station‡	
	Oat Silage (lb.)	Sunflower Silage (lb.)	Oat Silage (lb)	Corn Silage (lb.)	Oat Silage (lb.)	Hay-Crop Silage (lb.)
Daily gain	2.48	2.28	2.88	3.08	2 09	2.29
Feed per cwt. gain						
Grain	408	525	568	507	535	504
Protein conc.	37	41	81	72	54	4
Hay	129	161	70	65	...	...
Silage	1,300	1,562	608	622	1,126	1,158

* University of Alberta, Bulletin No 8.
† Mimeographed Report of Cattle Feeding Trials, 1928.
‡ Mimeographed Report, 1954.

Perhaps even more important than the increased income from the oat crop as a result of harvesting as silage is the improvement in stand obtained from the legume-grass seeding which usually accompanies the oat crop. A good clipping of hay from the new legume-grass seeding during the first fall is not uncommon when the oat nurse crop is removed as silage instead of by the usual combining procedure.

Millet Silage. Formerly several varieties of millet were commonly grown by Corn Belt farmers as emergency hay crops. Millet is still occasionally sown in corn fields where the stand of corn has been ruined by floods or insects too late in the season to warrant replanting. It is a rank-growing crop and produces a large yield of hay per acre. The quality of hay, however, is poor because of the coarse texture of the plants and the presence of the numerous hard seeds found in the heavy heads.

Experiments show that the ensilaging of millet greatly improves its value as a feed. In the silo the seeds absorb sufficient water to render them soft, so that they are more easily eaten by cattle. Because of the small amount of labor involved in growing and harvesting millet, the high yields obtained, and the fact that it matures in sufficient time to allow it to be seeded after a crop of wheat or early oats is removed, millet silage can be produced at a very low cost per ton. In feeding value, however, it is distinctly inferior to corn silage, as shown in Table 193, at least when it is fed as the principal ingredient in the ration.

Canning Refuse. The pea vines, cobs and husks from sweet corn, and beet leaves that accumulate around large canning factories are quite generally used for finishing beef cattle. Frequently these materials are allowed to accumulate in huge stacks which in time become "natural silos" through the exclusion of air from the interior by the

Table 193

Millet Silage for Finishing Cattle*

Two-Year-Old Steers Fed 120 Days	Corn Silage	Millet Silage
Daily gain	2.33 lb.	1.82 lb.
Feed per lb. gain		
Silage	27.82	40.76
Linseed meal	1.22	1.56
Oat straw	0.76	0.77

* South Dakota Bulletin 189.

decomposition of the material at the surface. Not only the top but also the sides of the pile may be spoiled for a distance of 2 to 3 feet, depending on the nature of the material and the care with which it has been stacked.

Some farmers who live in the vicinity of canneries realize the feeding value of this refuse and are willing to buy it and store it in modern silos. Often it is returned to the owners of the land on which the crops were grown in partial payment for the use of the land leased by the canneries, or it is returned in partial payment for the canning crop purchased.

The feeding of cattle in the vicinity of canneries is quite generally practiced, both because of the large amount of cheap feed available and because a supply of manure must be available to keep the soil at its maximum productivity. Owing to the wide variation in such silages resulting from different kinds of crops, different stages of cutting, and different methods of storing, no definite rules for feeding can be given. In general, much better returns are secured from feeding them in combination with grain and hay than from feeding them alone.

Wet Beet Pulp. In the sugar-beet growing areas of Colorado and other beet-producing states, large quantities of wet beet pulp are used in finishing cattle for market. Whether it is fed directly from the mill or from a silo, its feeding value compares favorably with that of corn silage.

Potato Silage. Silage made from surplus or cull potatoes compared favorably with corn silage as a feed for beef calves in tests of these feeds made at the Colorado station. Each ton of potato silage replaced 2,642 pounds of corn silage, 42 pounds of barley, and 7 pounds of linseed cake but required 476 pounds more alfalfa hay.[6]

[6] Colorado Bulletin 422.

chapter **22**

GRASS AS A FEED FOR FEEDER CATTLE

The contribution of grass, as such, to the finishing ration may vary from being the only feed used to not being used at all. The first situation is found when older feeder cattle, such as 2-year-old or older steers or slaughter cows, are sold for slaughter directly from grass. The degree of condition attained naturally is seldom sufficient for such slaughter cattle to grade above good or low choice. At the other extreme we have the cattle that are fed finishing rations in dry lot where the sources of roughage consist of harvested hays or silage. Sometimes the only roughage fed is the corn cob contained in ground ear corn, but this situation is of doubtful practicality, as discussed elsewhere.

Grass makes its greatest contribution in those finishing programs that are conducted during the summer. In these situations various combinations of grass and concentrates are used, depending upon the relative amounts of grass or pasture to be harvested and sold through feeder cattle and the amounts of grain or concentrate available, the time at which cattle are to be sold, and the availability and skill of the labor being used.

With the steady rise in tillable land values in recent decades, many of the large permanent pastures were plowed up. Thus, many farmers were forced into winter feeding, particularly in the prairie sections where all the land was tillable. For the small farmer who perforce must keep most of his land in cultivated crops, winter feeding has certain advantages, as will presently be pointed out. But to that man who, because of the large size of his farm or the presence of rolling or timbered land, has a considerable area of pasture, summer feeding always has an appeal for these reasons:

Advantages of Summer Feeding on Grass. 1. Summer gains on pasture are usually cheaper than winter gains.

a. Less grain is eaten per pound of gain.

b. Grass is a cheaper form of roughage than harvested hay.

c. Less labor is required in feeding and caring for cattle.

(1) The labor involved in the feeding of roughage is eliminated.

(2) Frequently only one feed of grain per day is given to cattle on grass, whereas two feeds are customary in a dry lot.

(3) Owing to favorable weather conditions and to the fact that the roughage—grass—is highly palatable, supplying the grain through a self-feeder is likely to be more satisfactory in summer than in winter feeding.

2. As a rule, larger daily gains are secured in the summer than in the winter over feeding periods of equal length. Cattle are likely to be more comfortable in summer than in winter because weather conditions are more uniform and feed lots are not muddy. In addition, summer rations are on the whole superior to winter rations, as explained in the following paragraph

3. Cattle fed on pasture during the summer usually get a better-balanced diet than cattle fed during the winter in dry lot. Fresh pasture forage is an excellent source of protein, minerals, and vitamins. Hence, cattle fed on pasture are not often handicapped by a shortage of one of these important nutrients.

4. No investment in buildings to afford shelter is required.

5. Swine following cattle on grass make larger gains and show a lower death loss than those following cattle in a dry lot.

6. The manure produced is spread on the fields by the cattle themselves, thus avoiding much loss of fertility through leaching and heating, as well as saving much labor.

7. Summer-fed cattle are commonly marketed during the late summer and fall when well-finished cattle are usually higher than at any other season of the year. Winter-fed cattle, on the other hand, are marketed in the late winter and spring when the prices paid for fed cattle are relatively low.

Disadvantages of Summer Feeding on Grass. Summer feeding of cattle on grass has certain disadvantages. As mentioned above, these disadvantages are more likely to apply to the small farmer who has a quarter-section or less of land than to the man who owns several hundred acres.

1. The land needed for pasture may return a larger gross cash income if planted in crops.

2. An adequate supply of feed in the form of grass is uncertain,

owing to the possibility of unfavorable weather. Winter killing or a late freeze after germination may result in the complete failure of rotation pasture. Insect or hail damage is always a threat.

3. Grain, especially corn, is relatively scarce and high in price during the summer and early fall.

4. The farmer has less time to devote to cattle in summer than in winter.

5. Flies and extremely hot weather may cause cattle much discomfort.

6. If permanent pastures are used the manure is dropped on the same fields year after year.

7. Shade and water are hard to provide in temporary and rotated pastures.

8. Feeder cattle are scarce and high in price in the spring, and the grade and weight desired are hard to obtain.

9. Beef steers lacking somewhat in condition or quality sell rather poorly in the fall because of the competition which they encounter from western grass cattle at this season of the year.

10. Summer pasture feeding programs are not so well adapted to use of labor-saving equipment such as that used in larger feed yards, unless self-feeding is practiced.

11. Weather damage to feed is a real possibility due to rain and windstorms which are more prevalent in summer time.

12. Swine are less apt to utilize completely the grain voided in manure dropped on pasture.

Dry Lot vs. Pasture for Summer Feeding. A considerable number of cattle are fed in dry lot for the late summer and fall markets. However, a majority of these cattle are purchased in the fall and have been fed considerable grain by the arrival of spring. Consequently they usually carry too much flesh to be fed on pasture during the summer and therefore are kept in the dry lot until they are ready for market. Only steers of strictly choice grade justify such a long feeding period, but if they possess sufficient quality and finish to sell near the top of the market, they usually are more profitable than they would be if marketed earlier, because of the higher prices paid for choice and prime steers during the late summer and fall.

Although it is generally agreed that cattle in good, thrifty feeder condition in the spring make faster and more economical gains when fed on pasture than they do in the dry lot, it is often claimed that these advantages are more than offset by the lower prices received for pasture-fed cattle when they are marketed. This opinion is well

supported by numerous feeding experiments in which the prices paid for the lots fed on pasture have usually been 25 cents to $1.00 a hundred less than for those fed in the dry lot. Buyers defend these prices by saying that cattle fed on pasture yield less beef in proportion to their live weight, that their carcasses have a higher shrinkage, and that the beef is of poor color. The lean is too dark, whereas the fat is yellow instead of the white color found in cattle fed in the dry lot. Although none of these claims except the one relating to the fat color has been supported by slaughter and carcass studies made by impartial investigators, the fact remains that market buyers look with disfavor upon pasture-fed cattle, even though they show good quality and finish. Such cattle can be distinguished while they are alive from dry-lot cattle by their rough, dry, sunburned hair and by the greenish color of their feces. Removing the cattle from pasture about 2 weeks before marketing corrects the color of the feces, but

Table 194

COMPARISON OF DRY LOT AND PASTURE FOR SUMMER-FED STEERS

	Full-Fed in Dry Lot					Full-Fed on Pasture				
	Daily Gain	Shelled Corn per Day	Feed per Cwt. Gain		Selling Price per Cwt.	Daily Gain	Shelled Corn per Day	Feed per Cwt. Gain		Selling Price per Cwt.
			Conc.*	Hay				Conc.*	Hay	
2-year olds:										
Illinois Bull. 328	2.12	19.7	927	411	$10 40	2 00	19 9	992		$10 50
Kentucky Mimeo. Report, 1934–1936 (3-year-average)†	1 81	10.1	608	908	8.47	2 07	10.1	531		8 55
St. Joseph stockyards, 1916	3 08	18 2	671	288	11.10	2 76	18 6	763	112	10.25
Average 5 trials	2.13	13.6	684	685	10 98	2.19	13.8	670	20	10 70
Yearlings										
Kansas Circ. 117	1.76	11.5	706	242‡	10 75	2.10	13 0	667	55‡	11.25
Ohio Bimonthly Bull. 138	1.88	12.8	787	401‡	16.50	2 36	12.7	625		16 25
Ohio Bimonthly Bull. 144	1.92	15.0	840	331‡	13.55	2 13	15.0	758		12 91
Missouri Mimeo. Report, 1933	1.85	13.4	804	121	6 25	2 18	15 5	780		6.40
Missouri Mimeo. Report, 1934	2.32	12.9	611	229	8 00	2.20	12.3	613		7.75
Missouri Mimeo. Report, 1935	2.46	15 4	680	135	11.50	2.13	12 7	653		10 60
Nebraska Bull. 354 (Average of 3 trials)	2.19	16.1	743	187	6 48	2.31	15 7	686	112	6.37
Illinois Mimeo. Report 1935	2.45	14.1	618	204	11.00	2.34	12.3	483	58	10 00
Average of 10 trials	2.12	14.3	728	222	9 70	2.24	14.1	665	45	9 43

* Grain plus protein concentrate.
† Mixed pasture used in this experiment.
‡ Includes some silage reduced to dry roughage equivalent.

even a month of dry-lot feeding usually does not improve their hair sufficiently to escape some price discrimination. Obviously no improvement in the appearance of the hair is obtained unless the dry lot contains a barn or shed which affords protection from the sun.

Despite the fact that the financial statements on comparable droves of cattle frequently show a larger net return over feed costs for dry-lot than for pasture feeding, it should not be assumed that this system of feeding is necessarily better under all conditions. Such financial statements seldom take into account the relative farm costs of harvested roughages and pasture, the relative amounts of labor expended in feeding, or the comparative quantities of manure recovered and returned to the land. All these items are very much in favor of the pasture-fed cattle. Hence, all things considered, the net difference between pasture and dry-lot feeding is not great. The summarized data in Table 194 give pertinent information on this subject. It should be pointed out that some of the earlier tests reported dealt with non-legume pastures but, if anything, the use of legume or legume-grass pastures favors pasture feeding.

In the final analysis, the amount of available pasture is the factor that usually determines whether cattle purchased in the spring or carried through the winter in stocker condition are fed on pasture or in the dry lot. If the topography of the farm or the crop rotation results in a larger acreage of pasture than is needed by the ordinary

FIG. 84. Full-fed steers self-fed on rotation pasture. Whether or not to self-feed on pasture in the summer time, rather than in dry lot, is a matter for each farmer to decide after weighing the advantages against the disadvantages. (Corn Belt Farm Dailies.)

stock, the cattle, in all likelihood, have been purchased mainly for the purpose of utilizing the otherwise surplus grass. Thus, in the Corn Belt at least, feeding on pasture is likely to be the result of a system of farming rather than a separate project undertaken because of advantages peculiar to the enterprise itself.

Selecting Cattle for Summer Feeding. Cattle to be finished during the summer may be purchased any time between September or October of the preceding year and the date on which it is desired to turn them on grass. Purchases made in the fall consist largely of calves and yearlings, which make considerable growth during the winter before the period of heavy feeding begins. Spring purchases, on the other hand, are often mature steers or yearlings with sufficient flesh to insure their being in choice slaughter condition after a feeding period of 4 or 5 months.

Regardless of their age and time of purchase, cattle that are to be fed during the summer should be selected with considerable care. Because of the expense of wintering, or their high cost per hundredweight if bought in the spring, cattle when turned on grass represent a large investment. This high initial cost, plus the relatively high value of corn during the summer months, makes a high selling price imperative if a profit is to be realized. With heavy receipts of grass-finished steers at all central and western markets during the late summer and fall, a satisfactory selling price can be expected only for cattle of strictly good, choice, and prime grades. Hence, cattle intended for summer feeding should possess such breeding and quality as insures their being graded low-choice or better when they are marketed.

Steers are usually more suitable than heifers for summer feeding. The large fall runs of grass-finished steers, together with the thousands of cows and heifers that are culled from breeding herds at the end of the grazing season, make for a rather inactive female butcher stock market during the fall months. Although cows and heifers finished on corn command a premium over those accustomed to an exclusive grass diet, the advance in selling price may not be sufficient to leave a profit after feed bills, labor charges, and marketing expenses have been paid.

Steers bought in the spring for summer feeding should possess a fair amount of flesh; otherwise it is difficult to make them ready for market by the end of the grazing season. In selecting steers with plenty of flesh one should be careful to avoid cattle that have been "warmed up" on corn, or, what is still worse, poor-doing steers cut from droves that have been fed corn all winter. Most experienced

feeders prefer cattle that have never had any corn. Two-year-old western hay-fed steers or yearlings wintered in the Corn Belt principally on corn silage make ideal cattle for summer feeding. Whereas each spring thousands of half-fat, corn-fed steers are sent back to the country for further feeding, the gains made by such animals are, as a rule, more expensive than those made by cattle unaccustomed to a heavy grain diet.

Varieties of Pasture. Prior to the mid-1930's bluegrass was the pasture most commonly used in the summer feeding of steers. Even though legume-grass rotation pastures have taken over as the most important pasture for summer feeding, bluegrass is still considered by many to be an especially valuable forage for grain-fed cattle because it does not tend to cause scouring or bloat. It is ready to graze much earlier in the spring than are most of the legume forages, and its firm sod withstands trampling much better than most other pasture crops. During the spring and early summer, bluegrass is palatable and nutritious but after ripening its seed in midsummer it becomes more or less dormant, especially during a dry season. At this stage it is not so palatable, and cattle getting a full feed of grain eat comparatively little of the grass. It is this tendency to go dormant that reduces the carrying capacity of bluegrass and consequently lessens its value in a summer feeding program. True, with the coming of fall rains and cooler weather, it starts growing again and often furnishes considerable grazing during September and October. The common practice is to remove the cattle to the dry lot before this growth begins, however, lest the new, green grass interfere with the consumption of grain. The fall growth of bluegrass pastures is utilized to greater advantage by newly purchased stocker calves or yearlings.

Along the western and northern borders of the Corn Belt, bluestem, brome-grass, and orchard-grass pastures are used extensively for summer-fed steers. All these pasture forages are similar to bluegrass in composition, and similar gains may be expected from their use. Recently brome grass has been grown extensively in the Corn Belt proper, where it has given considerably better results than bluegrass, particularly when it is mixed with alfalfa.

Many cattle feeders of the old school look with disfavor upon straight legume pastures for grain-fed cattle, believing that they produce both scouring and bloat. However, comparisons of these forages with bluegrass have shown that legume pastures are capable of producing so much more gain per head and per acre that they must be rated as valuable pasture crops for cattle despite these objections. Both red clover and alfalfa, either alone or in mixtures, have given

Table 195

Value of Legume Forages for Steers Full-Fed on Pasture

	Nebraska Bulletin No. 315			Illinois Mimeo. Rpt. 1930			Illinois Mimeo. Rpt. 1935		
	May 5–Nov. 3 182 days			May 4–Oct. 23 172 days			May 6–Nov. 15 193 days		
Yearling Steers *Initial Weight* 550 @ 650 lb.	Dry Lot	Alfalfa Pasture	Native Pasture	Bluegrass Pasture	Red Clover Pasture	Sweet Clover Pasture	Brome Grass Pasture	Alfalfa Pasture	Mixed Clover Pasture‡
Date turned on pasture	.	May 5	May 5	May 5	May 5	May 5†	May 6	May 6	May 13
Date turned off pasture	.	Sept. 22	July 28	Oct. 23	Oct. 23	Oct. 23	Sept. 23	Sept. 23	Sept. 23
Days on pasture	...	140	84	172	172	172	140	140	133
Steers per acre	...	3	2	2	2	2†	2.4	2.4	2.4
Days in dry lot	182	42	98	None	None	None	53	53	53
Av. daily gain on pasture	2.67*	2.70	2.49	2.16	2.47	2.27	2.25	2.44	2.28
Av. daily gain in dry lot	2.19*	2.60	2.51	.	...	.	2.57	2.36	2.27
Av. daily gain total period	2.41	2.68	2.50	.	.	.	2.34	2.42	2.28
Feed per cwt. gain									
Shelled corn	659	605	661	658	663	648	574§	553§	609§
Prot. conc		65	141	45	44	44	25	24	27
Alfalfa hay	289	29	18			.	58	57	62
Selling price per cwt.	$11.15	$11.35	$11.40	$15.10	$15.50	$15.25	$10.00	$10.25	$10.25
Hog gains per steer, lb	.	.	..	67	67	58			

* Average daily gain in dry lot before and after July 28

† Spring seeding of sweet clover used after August 7, one steer per acre.

‡ Clover mixture: approximately 80% sweet clover and 20% red clover.

§ Weight of ground ear corn.

much larger and more economical gains than bluegrass in experiments conducted at the Illinois station. (See Table 195.) Fairly good results have been obtained with sweet clover but the short grazing season of the second years' growth makes it necessary to transfer the cattle to other pasture or to the dry lot about the middle of August.

One important fact disclosed by the Illinois experiments is that the feeding of ground ear corn *to steers on legume pastures eliminates* both scouring and bloating to a great extent. Apparently the cobs serve as a substitute for the dry roughage that is frequently fed to *cattle on legume pastures to prevent these conditions.*

Another legume forage in which there is a great deal of interest at present is lespedeza. Since lespedeza is a self-seeding annual it does not, as a rule, attain sufficient growth to be grazed heavily until about July 15. From this date until frost it produces a wealth of palatable,

nutritious forage. The Missouri station reports 106 pounds of cattle gains per acre from lespedeza during a 6½-week grazing period in comparison with only 25 pounds per acre from bluegrass. No grain was fed in these grazing trials but the data do amply demonstrate that lespedeza very nicely fills in the gap during a period when grasses are less productive.

Turning Steers on Pasture. Better results are secured if the forage is allowed to make a fairly good start before the cattle are turned onto it in the spring. The first growth that appears is high in moisture and very low in energy content. April 20 to May 1 usually sees bluegrass sufficiently mature to be used in the central part of the Corn Belt. In the famous bluegrass sections of Kentucky and Iowa the grazing season opens about 10 days earlier and later, respectively.

Steers that have received a heavy feed of grain during the winter months are an exception to the above statements regarding the proper time to turn onto bluegrass. Better results are usually obtained if such cattle are turned onto the pasture in late March or early April as soon as the grass begins to grow. In this way they become accustomed to the grass so gradually that they do not tend to lose their appetite for corn. When full-fed cattle are turned onto a heavy growth of grass their consumption of grain temporarily falls off, sometimes to only half of what it was in the dry lot. Although the cattle usually regain their appetite for grain by the end of the third or fourth week it is obvious that the gains made during such a transition period are far from satisfactory.

Steers should never be turned onto straight legume or legume-grass rotation pastures before the pastures are 6 to 8 inches high. Grazing too early results in a reduction in forage production through the remainder of the grazing season. Such pastures usually reach the desired height by April 15 to May 10 in the principal cattle-finishing areas, with earlier dates in the South and West.

Bloat. The increased use of legume and legume-grass rotation pastures has resulted in a proportionate increase in the incidence of pasture bloat This type of bloat is often fatal and is not to be confused with the troublesome, but less dangerous, common feedlot bloat. Tremendous economic losses are incurred during some years due to deaths and the poor performance of bloated animals. Of even greater importance, however, is the loss resulting from failure to use these nutritionally more valuable pastures instead of grass pastures simply because of the farmer's fear of bloat.

A complete and satisfactory explanation for the cause or causes of bloat is still lacking, but vigorous research is presently going on in

this field, and it is believed by many that the solution of this problem is not too far distant. Space does not permit a discussion of the many theories on the causes of bloat. Some old and new recommendations for preventing and controlling bloat are as follows:

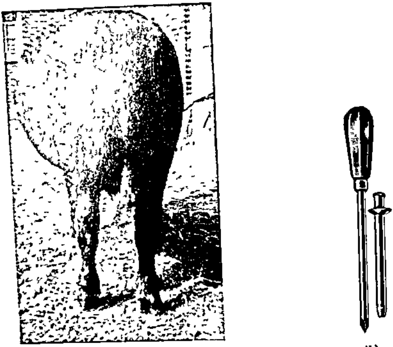
1. Permit cattle to fill on grass or hay prior to first turning out on pasture.
2. Allow cattle free access to dry forage or a grass pasture adjacent to the legume pasture.
3. Leave cattle on the legume pasture 24 hours a day rather than penning them at night.
4. Use pasture mixtures which provide no more than 50 per cent of legume forage.
5. Mix additional cob or oats with ground ear corn or other grains fed on legume pasture.
6. Supply 50 to 75 milligrams of penicillin per head per day in a supplement or in the salt mixture. Other antibiotics are also used by some feeders.
7. Keep a supply of blackstrap molasses in a self-feeding tank or bunk before the cattle at all times.
8. Supply 0.20 to 0.25 pound of fats or oils per head per day, either in a supplement or in the drinking water in emulsified form.

At times none of the above recommendations will prevent or control bloat, but a certain amount of control has been reported from their use.

There are almost as many methods for the treatment of bloat as there are recommendations for preventing it. The presence of bloat is easily recognized by a pronounced swelling of the left flank. So long as the distention causes the animal no great discomfort there is no need for alarm since recovery usually occurs without treatment. However, the bloated animal should be kept under observation since the condition occasionally becomes worse very quickly.

If bloating persists or proceeds to a more advanced state, treatment may be necessary. Treatment consists in administering medicines that arrest the further formation of gas in the paunch and provoke the belching up of that which is already there. One pint of mineral oil or 2 ounces of aromatic spirits of ammonia or 2 ounces of turpentine diluted with a pint of cold water often bring relief.

Probably the most desirable way of relieving acute bloat is to permit the escape of the gas through a 6-foot length of smooth ½- or ⅝-inch rubber hose, one end of which is inserted far back in the mouth and carefully pushed down the esophagus and into the paunch.



(a) (b)

FIG. 85. (a) A badly bloated steer. (b) Trocar and cannula for tapping dangerously bloated animals. (O. M. Franklin Serum Company, Denver, Colorado.)

With a little practice no difficulty should be experienced getting the end of the hose over the trachea and into the esophagus.

Should the formation of gas proceed despite the medicines administered, or after use of the stomach tube, it is necessary to tap the paunch to permit the gas to escape. The paunch is tapped by means of a trocar, which is a sharp-pointed instrument encased in a sheath called the cannula. The point of the trocar is placed at a spot on the left side of the animal equidistant from the last rib, the hip bone, and the transverse processes of the lumbar vertebrae. The handle is then struck sharply with the palm of the hand in the direction of the right knee of the animal. Then, while the cannula is kept in place, the trocar is withdrawn, permitting the gas to escape slowly.

Applied research that looks most promising for the prevention of bloat is that in which antibiotics are being used in conjunction with pasture supplements, including salt and mineral supplements, and that in which specially prepared fats and oils are included in the pasture supplements or drinking water. Any material that must be included in a pasture supplement has a disadvantage in that it necessitates the feeding of a supplement, whereas the farmer may wish to make

the most economical gains by the use of pasture alone. Materials that must be added to the drinking water can, of course, be used only when water tanks or troughs are used instead of ponds or streams.

Day Versus Night Grazing. Many farmers who full feed their cattle during the summer confine them in the dry lot overnight and turn them onto the pasture during the day. The object of this procedure is to induce the cattle to eat as much grain as possible by holding them in the feed yard.

Since cattle that are continually on pasture spend more time grazing at night than during the day, especially in hot weather, it would appear that confining them in the lot during the day, where they would have access to water and shade, and turning them onto the pasture at night might be a better procedure. These two methods of using pastures were compared at the Illinois station. A third and fourth lot, fed in dry lot and on pasture, respectively, were also included in the test. Grazing at night proved to be much the best plan of utilizing the pasture. Observations of the cattle disclosed that those confined in the dry lot during the day and turned onto the pasture at night usually grazed steadily for about 3 or 4 hours after they were turned onto the pasture, whereas the cattle pastured during the day usually sought the protection of an artificial shade soon after they were put into the field. The principal difference observed between the cattle pastured at night and those left on pasture continually was that the night-pastured cattle spent much time during the day lying in their well-bedded shed, while the cattle continually in the pasture stood most of the time under their sun shade. (See Table 196.)

Grain Rations for Pasture-Fed Steers. Corn is the usual grain fed to cattle on pasture. Its concentrated form makes it combine well with a bulky roughage such as pasture. Ground ear corn is too bulky and unpalatable for cattle fed on non-legume pastures but is better than shelled corn for cattle on sweet clover or alfalfa because the cob particles tend to reduce the prevalence of scours and bloat.

Owing to the relatively high percentage of protein in young grasses or legumes, the need for a nitrogenous concentrate is by no means as urgent with pasture- as with dry-lot fed cattle. Except for slightly higher daily gains resulting from a larger consumption of the more palatable ration, no important advantage is to be secured from feeding protein supplements to full-fed steers that have access to an abundance of fresh, high-quality green pasture. However, bluegrass and brome grass, as well as all legume forages, contain a much lower percentage of protein in midsummer than they do in the spring. Moreover, they are less palatable and consequently are consumed in smaller amounts.

Table 196

A Comparison of Night- and Day-Grazing for Full-Fed Cattle*

	Confined in Dry Lot	On Pasture at Night	On Pasture during Day	On Pasture Continually
Av. daily gain, lb.	1.74	2.20	1.99	2.00
Av. daily ration				
Shelled corn	12.3	13.6	12.4	13.7
Soybean oil meal	1.0	1.0	1.0	1.0
Clover hay	4.7	1.9	1.8	0.2[a]
Pasture, acres per steer	....	0.25	0.25	0.50
Feed per cwt. gain				
Shelled corn	706	617	625	686
Soybean oil meal	55	45	49	49
Clover hay	272	86	93	11
Pasture days	....	11	12	24
Selling price per cwt.	$11.75	$12.25	$12.00	$12.00
Return per head above feed costs	14.00	25.72	20.58	16.89

* Illinois Mimeo. Report, Nov. 14, 1941.
[a] Hay fed in dry lot 6 days before marketing.

Table 197

Shelled vs. Ground Ear Corn for Cattle Full-fed on Pasture

	Mixed Pasture*			Bluegrass†		Alfalfa†	
	Shelled Corn	Ground Shelled Corn	Ground Ear Corn	Shelled Corn	Ground Ear Corn	Shelled Corn	Ground Ear Corn
Av. weight, lb.	660	667	667	703	709	705	708
Days fed	190	190	190	133	133	133	133
Av. daily gain, lb.	2.47	2.40	2.19	2.38	2.08	2.31	2.32
Av. daily ration							
Shelled corn	16.6	15.9	15.3[a]	15.0	13.2[a]	12.8	11.4[a]
Protein conc.				1.0	1.0	1.0	1.0
Alfalfa hay	2.2	2.4	2.3	..	. .	...	....
Feed per cwt. gain							
Shelled corn	673	663	654[a]	599	635[a]	554	491[a]
Alfalfa hay	90	98	105	.	....	....	....
Selling price per cwt.	$5.50	$5.50	$5.50	...	....	....	....
Gain of hogs per steer				63	23	66	38

* Nebraska Mimeographed Circular 140.
† Illinois Mimeographed Report, 1934.
[a] *Shelled basis.*

For these reasons a protein concentrate should always be fed with the grain on grass pastures beginning about July 1 and on legume pastures about August 1, unless unusually favorable weather conditions delay the maturing of the forage beyond the usual time. The need for a protein concentrate during the summer and fall by cattle fed on bluegass pasture is well shown by Table 198. Many feeders feed protein supplement from the start of the grazing period to make certain that they do not wait until the pasture is too dry before starting the use of the supplement. In such cases, and especially if the pasture is a legume-grass or straight legume, feeders may widen the usual 10–12 : 1 ratio of ground ear corn to protein concentrate to 12–15 : 1 during at least the first two months of the grazing season.

Turning Half-Fat Cattle on Grass. Cattle that have received a fairly liberal ration during the winter, so that they are half fat or

Table 198

VALUE OF A PROTEIN SUPPLEMENT AT DIFFERENT STAGES OF THE GRAZING PERIOD FOR STEERS FED ON BLUEGRASS PASTURE

	First Period		Second Period		Total Period	
	May 5 to June 30		July 1 to October 20		May 5 to October 20	
	Av. Daily Gain	Feed Per Cwt. Gain	Av. Daily Gain	Feed Per Cwt. Gain	Av. Daily Gain	Feed Per Cwt. Gain
Missouri Bulletin No. 90*						
(Av. 4 trials)						
Corn alone	2.26	613	1.76	1581	1.97	940
Corn and C. S. M.	2.27	612	2.05	1332	2.12	833
Missouri Mimeo. Rpts.						
(Av. 3 trials)						
Corn only 1st 56 days Corn 8 : C. S. M. 1, last 112 days	2.46	330	2.33	771	2.37	637
Corn 8 : C. S. M. 1, 168 days	2.44	334	2.30	806	2.30	671
Corn only 1st 56 days Corn 12 : C. S. M. 1, last 112 days	2.47	330	2.23	820	2.31	667
Corn 12 : C. S. M. 1, 168 days	2.64	324	2.38	776	2.47	600

* First period, May 1–July 31, second period, August 1–December 1

Table 199

DRY LOT *vs.* PASTURE FOR FINISHING HALF-FAT CATTLE*

Place Finished	1st Trial		2d Trial		3d Trial		Average 3 Trials	
	Dry Lot	Pasture	Dry Lot	Pasture	Dry Lot	Pasture	Dry Lot	Pasture
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Weight in Spring	830	880	870	875	827	809	859	855
Average daily gain:								
1st month	2.06	0.66	2.16	1.61	2.37	1.34	2.20	1.20
2d month	1.90	2.05	1.58	1.41	1.35	1.66	1.61	1.71
3d month	1.01	1.00	1.38	1.56	1.35	1.38	1.25	1.31
Total — 90 days	1.65	1.24	1.71	1.53	1.69	1.48	1.68	1.41
Grain eaten per day:								
1st 10 days	14.90	8.22	14.55	10.27	16.00	14.50	15.15	11.00
Total — 90 days	17.04	11.84	16.17	14.46	18.74	15.92	16.65	14.07
Grain per lb. gain:								
1st month	7.60	13.94	7.06	6.62	6.96	11.02	7.21	10.53
Total — 90 days	10.28	9.55	9.46	9.45	9.89	10.88	9.88	9.98

* Indiana Bulletin 142.

better at the opening of the grazing season, should be finished in a dry lot rather than on grass. To turn such animals on pasture will in all probability result in a marked decrease in grain consumption for the first 3 or 4 weeks while they are becoming accustomed to grass. This decreased consumption of grain, together with the "washy" character of the spring pasture, results in only very moderate gains for the first month or 6 weeks. In fact, it is not unusual for cattle under such conditions to show an actual loss in weight when weighed 2 or 3 weeks after leaving the dry lot.

Should it be necessary to put half-fat cattle on pasture because of a scarcity of dry roughage, they should be turned on grass early in the spring when the grass first starts to grow, and their dry roughage should be continued until the grass is fairly mature. In this way the cattle become accustomed to the change in their ration very gradually and are not likely to go off feed. (See Table 199.)

Feeding Soilage or "Green Chop" in Dry Lot to Finishing Steers. Modern methods of harvesting forages for silages are being adapted to daily cutting of forage for feeding in dry lot in the fresh state or as soilage. This system of utilizing legume-grass or legume forage is especially suited to operators of feed yards and to large farm feed lots. The following advantages of this system of harvesting and

feeding summer forage are responsible for its acceptance by the larger feeders:

1. Carrying capacity of pasture is doubled owing to more complete utilization of the crop.
2. The quality of the forage is higher, by at least one government grade, over the same forage harvested and fed as hay, if harvested at the proper stage.
3. The forage has a more uniform quality.
4. Ration changes and adjustments can be made more accurately and conveniently.
5. Less fence, shade, and watering equipment are required.
6. The cattle expend less energy, since walking about the pasture is eliminated.
7. Fewer cases of bloat occur, although soilage is not a sure cure for bloat.
8. Flies are easier to control in dry lot than on pasture.
9. The process of checking cattle for disease, bloat, and other problems is simplified.
10. Weeds and insect damage to pastures are easier to control.
11. Puddling and packing of pasture soil is lessened.
12. Condition of haircoat is better in cattle fed in dry lot.
13. Manure can be applied where it does the most good.

Some problems arise in this method of feeding and some are serious enough to cause some feeders who have tried soilage to abandon the plan. The disadvantages of soilage are:

1. Prolonged wet weather makes harvesting difficult or impossible.
2. Labor requirements are increased, especially in smaller operations. One study found that 0.4 man hour of labor was required per ton of fresh forage harvested.
3. Equipment costs are high; machinery costs amounted to $1.75 per ton in one study. If silage-making equipment is already on hand, however, this extra item of expense is small.
4. Numbers on feed need to be large—at least 100 head or more—in order to keep per head costs of labor and machinery down.
5. Scouring is prevalent with this type of feed.
6. Forage quality of roughage consumed may become poor if the crop becomes fibrous owing to advanced maturity. *Steers on pasture* would selectively graze only the new growth, thereby consuming a more nutritious roughage.
7. A system of feeding soilage is confining, in that fresh forage must be chopped daily.

Results of the Iowa experiments reported in Tables 200 and 201 show what can be expected from steers being handled under two different programs for utilizing pasture forage. In general, the contribution made to the ration by pasture forage was about double when it was harvested as soilage instead of as pasture in a steer program in which no grain was fed for 120 days, followed by a 75-day full feed of grain in dry lot for both lots. (See Table 200.) Profits per steer were no greater but *more steers could be fed per acre of pasture.*

In a comparison between steers full-fed on pasture and steers fed limited grain plus pasture forage harvested as soilage, the pasture made a very substantial contribution toward the total feed needs if

Table 200

COMPARISON OF PASTURE AND SOILAGE WHEN STEERS WERE GRAZED OR FED SOILAGE WITHOUT GRAIN FROM MAY TO SEPTEMBER (120 DAYS) AND FULL-FED IN DRY LOT FOR 75 DAYS*

(Average of 2 years)

	Grazing		Soilage	
	No Suppl	Suppl.	No Suppl.	Suppl.
Number of steers, 2 yr.	16	15	16	15
Av. initial weight, lb.	778	782	807	801
Av. final weight, lb.	1,183	1,182	1,186	1,176
Av. daily gain, lb	1.86	1.84	1.95	1.97
Av. feed consumed per steer daily.				
Pasture, brome-alfalfa, acres	0 85	0.85	...	...
Clippings, brome-alfalfa, lb.†			58.2	55 0
Ground ear corn, *lb.*	8.4	7.8	7.7	7.1
Hay, brome-alfalfa, lb.‡	0.4	0.4	0.9	0 9
Supplement, lb	0 6	1.8	0.4	1.8
Feed cost per cwt, gain, $	20 00	22.10	19.70	21.40
Selling price per cwt., $	23.16	23.45	23.36	23.10
Margin/steer over feed costs, $	22.13	16.79	25.25	14.83
Est. beef per acre, lb.	192	161	283	256
			1 5 T. hay	1.5 T. hay
Returns per acre of pasture, $	41.00		46.42	

* Iowa Miscellaneous Publication AH 693, 1955.

† Daily consumption during pasture season was 79 lb. per steer in the first year and 90 lb. in the second.

‡ *Daily consumption during finishing period was 3 lb. per steer in both years.*

Table 201

COMPARISON OF PASTURE AND SOILAGE WHEN STEERS ARE FULL-FED ON PASTURE OR LIMITED-FED GRAIN AND SOILAGE IN DRY LOT FOR 135 DAYS (Average of 2 years)*

	Grazing plus Full-Feed of Corn		Soilage plus Limited Corn†	
	No Suppl.	Suppl.	No Suppl.	Suppl.
Number of steers, 2 yr.	16	16	16	16
Av. initial weight, lb.	814	820	820	816
Av. final weight, lb.	1,123	1,162	1,125	1,130
Av. daily gain, lb.	2.32	2.56	2.33	2.39
Av. daily feed consumed:				
Pasture, brome-alfalfa, acres	0.25	0.25	. .	. .
Clippings, brome-alfalfa, lb.	. . .	.	51.6	49.2
Ground ear corn, lb.	20.8	20.1	13.6	13.4
Hay, brome-alfalfa, lb.	. . .	.	0.1	0.1
Supplement, lb.	. .	2.0	. .	2.0
Feed cost per cwt. gain, $	23.40	23.60	20.00	22.70
Selling price per cwt., $	24.18	24.88	21.58	21.18
Margin/steer over feed costs, $	21.29	28.41	35.30	25.52
Est. beef per acre, lb.	14	6	398	310

* Iowa Miscellaneous Publication AH 693, 1955.

† Ground ear corn, 5 lb. per steer daily during first month; 10 lb. second month, 15 lb. third month, and a full feed of ground ear corn thereafter.

harvested and fed as soilage. Profits per steer fed were considerably higher than when the pasture was grazed, especially if supplement was not fed. (See Table 201.)

Finishing Cattle on Grass Alone. Comparatively few cattle are *grazed without grain* in the Corn Belt with the expectation of selling them for slaughter in the fall. In only a few sections of the Central States is the grass sufficiently nutritious and abundant to put feeder steers in satisfactory killing condition without the aid of grain. The common practice, when no grain is fed on pasture, is to winter some stocker calves or to buy *light steers in the spring*, graze them until September or October, and finish them on corn during the fall and early winter. In other words, *the cattle are handled as "stockers"* during the summer as well as in the previous winter, and growth and development rather than a marked improvement in condition are the desired results. Good to choice, thrifty *steers weighing 500 to 700* pounds are the kind desired for this purpose. Thin or medium fleshy *animals, rather than fleshy animals*, are preferred since they can be bought with fewer dollars and make larger gains when turned onto

grass. With good grazing conditions such steers improve greatly in appearance and usually grade at least one grade higher in the fall than they did the previous spring. If marketed when removed from pasture they are not, as a rule, fat enough to be sold for slaughter but are returned to the country for further feeding. This is especially true if the steers are yearlings. Choice quality 2-year-old steers often attain enough finish on excellent pasture alone to grade low to average choice as slaughter cattle. However, most feeders who graze steers of this age and weight prefer to feed for 30 to 50 days in dry lot in order to improve the condition sufficiently for the steers to grade still higher. Ordinarily the 10 to 15 bushels of corn or sorghum required are more than paid for by the higher selling price received. Choice steers such as the fleshy 2-year-olds in Figure 86 would be ideal for this short feeding program.

Limited Grain Rations for Pasture-Fed Cattle. The feeding of a limited grain ration to cattle on pasture is not a common practice. Unless they are moved from the pasture to the dry lot each day for feeding, some of the animals may not be at the bunks when the grain is fed and therefore do not get any. The more common practice is to feed no grain at all during the first 2 or 3 months while the pasture is palatable and nutritious, and to supply a full feed during the late summer and fall when grazing conditions are less favorable. This plan has the advantage of utilizing the pasture when it is at its best, and of supplying an abundance of digestible nutrients during the period when cattle on even a limited feed of grain eat relatively little of the dry, unpalatable pasture. Another advantage of deferring the feeding of grain to the last half of the summer is that considerable labor is saved.

It has already been mentioned that the feeding of some form of dry feed on legume pastures reduces the tendency to bloat. Ground ear corn or oats, fed in limited amounts, are quite effective for this purpose and at the same time serve as a source of energy and as a moisture-absorbing agent in the digestive tract. This absorbent effect slows down the passage of the feeds consumed, which conceivably should improve digestibility and increase the absorption of nutrients. Thus if the pasture consists largely of succulent legumes, the limited feeding of ground ear corn or oats, which contain considerable fiber, seems justified although admittedly this recommendation is not based on extensive research.

Supplementing Range Pastures with Small Amounts of Concentrates. In the range states the most commonly used feed in times of extreme grass shortage is a protein concentrate, usually in

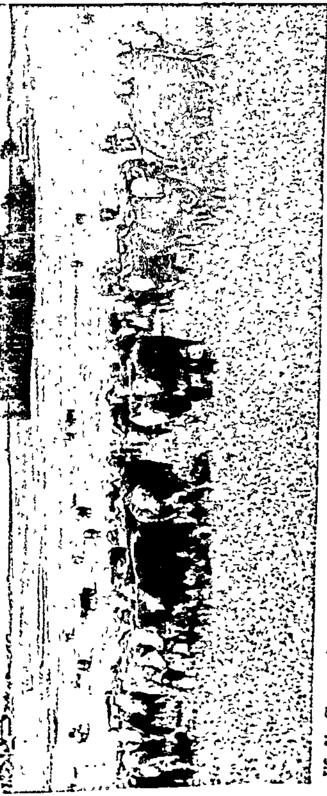


FIG. 86. Choice stocker steers on grass without grain, in Iowa. When grazed in areas outside the range areas, such steers as these are fed out before sale. (American Hereford Association.)

Table 202

THE VALUE OF PROTEIN CONCENTRATES AS SUPPLEMENTS TO BLUESTEM PASTURE IN PRODUCING GRASS-FATTENED STEERS*
(3-Year-Old Steers; Average of 3 Trials)

Average, Grazing Period: Apr. 25–Aug. 12 (109 Days)	Type of Supplement			
	None	C.S.M.	Ground Shelled Corn	C.S.M. After July 3
Av daily ration, lb.		3.4	3.4	3.3
Av. daily gain	2.19	2.62	2 54	2.47
Av selling price	$23.15	$25.15	$25.50	$24.15
Av. net return over feed costs	45.23	61.22	65.28	58.25
Av. dressing percentage	57.4	58.3	58.6	58.1

* Oklahoma Miscellaneous Publications 11, 13, and 15.

the form of "cake" or "cubes." These feeds are usually scattered on clean ground at the rate of 1 to 3 pounds per head daily. Often they are fed every other day at double the daily allowance in order to save labor and to insure that every animal gets at least a mouthful.

Since range pastures frequently mature early as the result of dry weather and are therefore low in protein, many ranchers feed cottonseed or soybean cake during the late summer and autumn to those cattle which they plan to sell in the fall. This practice results in heavier weights and higher selling prices per hundred because the cattle are more attractive to both packer buyers and Corn Belt feeders. In three trials conducted at the Oklahoma station, 3½ pounds of either cottonseed cake or shelled corn per head daily proved to be valuable supplements to bluestem pasture. Also, a supplement fed after July 1 was almost as effective as one fed during the entire grazing season All three lots fed the supplements were much more profitable than the check lot which was fed none. (See Table 202.) It is not likely that small amounts of concentrates give as favorable returns on rotation or improved pastures as were secured at Oklahoma except during a severe drought when very little green forage is available. If a supplement is to be fed while pastures are still green, shelled corn is preferred to a protein concentrate on the basis of the Oklahoma experiments

Self-Feeding Protein Concentrates on Range Pasture. The self-feeding of a mixture of cottonseed meal and salt to range cattle has

been practiced with apparent success for several years, especially in Texas. By varying the amount of salt in the mixture the desired consumption of protein concentrate is obtained. A mixture of 20 per cent salt and 80 per cent cottonseed meal usually results in the consumption of about 2 pounds of cottonseed meal daily by yearling steers on good range pasture. As the range grasses dry up and become less palatable it is necessary to increase the salt in the mixture to about 30 per cent of the total weight. This method of feeding a protein concentrate results in the consumption of far more salt than is needed by the cattle but no harmful results have been reported.

Gains Made from Grass. Gains made wholly from good pasture are, as a rule, 60 to 75 per cent as large as the gains made by cattle on full feed. On good pastures that furnish an abundance of forage, yearling steers gain 1.25 to 1.5 pounds per day for the entire grazing season. Two-year-olds should gain 1.5 to 2 pounds per day. Steers that have been poorly wintered and are very thin when turned onto grass make larger apparent gains, owing to the "fill" taken on during the first month.

The largest gains are usually obtained during June and July, when conditions for grazing are most favorable. Earlier in the year the grass is too soft and "washy" to be highly nutritious or to permit a high intake of dry matter. Later in the season it becomes dry and

Table 203

THE EFFECT OF AGE AND CONDITION UPON THE GAINS MADE ON PASTURE ALONE

	Kansas Flint Hills Section (U.S.D.A. Dept. Bull. 1454)				Southwestern Virginia (Virginia Bulletin 258)			
Class of Cattle	Days on Pasture	Acreage per Steer	Total Gain (lb.)	Aver. Daily Gain (lb.)	Days on Pasture	Acreage per Steer	Total Gain (lb.)	Aver. Daily Gain (lb.)
Thin aged steers	133	4.5	293	2.20	199	4	235	1.18
Half-fat aged steers	128	4.2	233	1.82	.	. .		
Fat aged steers	115	4.5	167	1.45		. .	.	
Thin 2-year-old steers	132	3.7	232	1.76	189	3.25	297	1.57
Half-fat 2-year-old steers	155	5.2	233	1.50	168	2.5	231	1.39
Thin yearling steers	168	3.9	206	1.23				
Half-fat yearling steers	187	4.0	193	1.03				

Table 204

SEASONAL VARIATIONS IN GAINS MADE ON PASTURE ALONE

	Missouri Bluegrass*		Illinois Bluegrass		Illinois Alfalfa		Illinois Brome Grass		Kansas Blue Stem		Virginia Bluegrass	
Source of Information	Mimeo. Rpt.		Mimeo. Rpt.		Mimeo. Rpt.		Mimeo. Rpt.		Kansas Circ. No. 97		Virginia Bull. No. 164	
	Days	Total Gain per Acre	Days	Av. Daily Gain	Days	Av. Daily Gain	Days	Av. Daily Gain	Days	Av. Daily Gain	Days	Av. Daily Gain
1st period	28	42 0	25	2 26	18	2.94	28	2.14	28	1 92	31	2.09
2nd period	28	22 7	28	1.90	28	2 96	28	2 37	30	2.33	30	3.53
3rd period	28	14 4	28	1.49	28	2 09	28	1.56	31	1.25	31	1.90
4th period	28	14 6	28	.89	14	1.63	28	.71	31	1.40	31	.53
5th period	28	9 0	28	2.23	28	2.36	28	.36	32	1.46	15	1.43
6th period	28	3.7	20	.75	24	1.33	28	.71	31	.20	..	....
7th period	..	.	..	....	.	....	17	.29	28	−.55	..	....
Total	168	106.4	157	1 80	140	2 16	185	1.32	209	1.15	138	1.94

* Average of 3 years.

unpalatable, as well as more indigestible, so that the cattle tend to eat and utilize little more than is required to maintain their weight. This reduced gain with the advance of the grazing season is largely responsible for the slower gain in younger cattle, as seen in Table 203, because their nutrient requirements are more critical than those of older steers. The data in Table 204 clearly show that gains after the *third month of the grazing season are drastically reduced.* Flies and extremely hot weather also are responsible for the smaller gains made during the late summer and early fall.

Green pasture is conducive to heavy "fills" at the time of shipment. Such fills mean a large shrinkage during transit, as well as low dressing percentages at the time of slaughter. Cattle that are soon to be marketed should therefore be kept away from green, tender pasture for 4 or 5 days before loading. A substitute may be either feeding them hay in a dry lot or turning them onto a pasture that consists of relatively ripe, mature forage.

Area of Pasture per Steer. Pastures vary so much in productiveness that no definite statement can be made as to their carrying capacities. One acre of average rotation pasture is commonly regarded

as the area necessary to pasture a 1,000-pound steer during a normal grazing season. Lighter cattle require a smaller area in proportion to their weight. Twice this area of bluegrass pasture is required, and improved permanent pastures range in between, if they are on good soil.

When cattle receive a full feed of grain, only one-third to one-half as much pasture is required as when the cattle are finished on grass alone. Some feeders use a minimum of pasture, feeding as many as 80 yearling steers and as many or more hogs on 20 acres. A pasture so heavily stocked, however, becomes so thickly covered with manure as to render the grass unpalatable. This is particularly likely to be true of pastures adjoining feeding yards that are used year after year. The presence of a heavy growth of pasture under such conditions is not always proof that the cattle have an adequate amount of pasture. The same cattle turned onto an equal area, similar as far as growth of forage is concerned but free from objectionable odors, might eat the grass down to the roots in the course of 2 or 3 weeks. As previously mentioned, green-chopping overcomes this objection.

The pasture should be no larger than is necessary to insure an adequate amount of forage, as shown by the work of the North Dakota Experiment Station in cooperation with the United States Department of Agriculture.[1] In these trials, covering a period of 6 years, it was found that 7 acres of range pasture per steer produced larger daily gains than either 5 or 10 acres. By observing the steers carefully throughout the day it was noticed that the cattle in the larger fields tended to spend more of their time walking about and less time in grazing than those in the smaller tracts. Steers in a 30-acre pasture walked 1⅝ miles per day; those in a 100-acre pasture, 3$\frac{1}{16}$ miles; and a herd of dairy cows in a 640-acre field of similar grazing land walked 5½ miles.[2]

Although these figures have little direct application to Corn Belt conditions where the pastures are relatively small, they emphasize the fact that cattle in large pastures spend a considerable amount of time and energy moving about on more or less aimless excursions. Anything that can be done to lessen this tendency, such as the providing of water and shade in various parts of the fields, results in larger and more economical gains.

A proper balance between cattle and available forage is indeed difficult to maintain. Heavy stocking insures the utilization of all available forage and a maximum gain per acre. However, under such

[1] U.S.D.A Department Bulletin 1170.
[2] North Dakota Bulletin 154.

conditions the cattle get somewhat less than what they want to eat and consequently make less than maximum gains per head. On the other hand, if the rate of stocking is low enough to insure each animal his fill of choice forage each day, some forage, especially the less desirable plants and plant parts, will not be eaten. The result is maximum gains per head but low gains per acre. (See Table 205.) A happy medium, represented by moderate grazing, is the desired goal but it is often difficult to attain, especially during abnormal weather conditions which greatly affect the growth of pastures.

Since legumes and mixtures of grasses and legumes grown in a 3- to 5-year crop rotation are valued largely for the nitrogen and organic matter they add to the soil, they should not, if pastured, be grazed too closely or they will be of little benefit to the grain crops that follow. It is much better to stock them with only enough cattle to eat 50 to 70 per cent of the forage, leaving the remainder to be returned to the soil. Even permanent pastures such as bluegrass and brome grass do not remain productive if they are grazed closely year after year. Under such unfavorable conditions the stand becomes thin and the bare spots are gradually taken over by weeds. A weedy permanent pasture is almost unmistakable evidence of overgrazing. It is believed that the rates of stocking recommended in Table 206 prevent overgrazing except during extremely dry years. As a result, permanent pastures become better with the passing of each year and

Table 205

Effect of Rate of Stocking upon Gain per Acre and Gain per Head*

	Overgrazed			Moderately Grazed			Undergrazed		
	Area per Head, acres	Gain per Acre, lb	Gain per Steer, lb.	Area per Head, acres	Gain per Acre, lb.	Gain per Steer, lb.	Area per Head, acres	Gain per Acre, lb.	Gain per Steer, lb
1946	1 87	36	67	3 2	49	156	5.4	33	180
1947	2 03	68	138	3 4	39	134	5.2	28	146
1948	2 03	95	193	3 4	69	234	5.2	48	248
1949	2.03	52	105	3.4	49	165	5.2	38	194
Average	1 99	63	126	3.4	52	172	5.2	37	192

* Kansas, Ft. Hays Station Reports, 1947–1950.

Table 206

RECOMMENDED RATE OF STOCKING BEEF CATTLE PASTURES IN NON-RANGE AREAS*

(Acres per Head)

	Permanent Grasses Unfertilized		Legumes or Mixed Grasses and Legumes in Rotation with Grain Crops	
	Yearlings	2-Year-Olds	Yearlings	2-Year-Olds
1. Pasture only				
a. Entire season	1.5	2 25	1 0	1.5
b. Until Aug. 1, then removed to dry lot	1.0	1 50	0 66	1 0
2. Full fed on pasture				
a. Entire season	0 5	0.75	0 33	0 5
b. After July 1	1 0	1.50	0 66	1 0

* For soils of average fertility which will produce 40 to 50 bushels of corn or 1½ tons of hay in an average season.

rotation pastures add large amounts of both nitrogen and humus to the soil. Stocking rates for the range area vary so much with rainfall and type of vegetation that local specialists should be consulted as to recommended rates.

Cattle Gains per Acre. Gains secured from improved pastures during recent years have been so high as to disprove the statement that the level lands of the midwestern farm belt are too valuable to be seeded to pastures for beef cattle. (See Table 207.) It is not difficult to show that an acre of pasture, which puts 300 pounds of gain on a yearling or 2-year-old steer each summer returns as much net profit per year as an acre of 80-bushel corn.

The most surprising fact disclosed by the pasture experiments listed in Table 207 is that the productiveness of pastures seems to bear little relation to the natural fertility of the soil. For example, pastures established on thin, eroded land at the Dixon Springs, Illinois, station have been somewhat more productive than those at Urbana on level, brown silt loam. Part of the difference may be explained by the longer grazing season, but the principal difference appears to be that the legumes encounter less competition from the grasses on the poor soil and therefore constitute a larger percentage of the available forage. Obviously much heavier applications of fertilizers, principally limestone and phosphate, are required on the poor soil in preparing it for seeding. Also more labor is usually required to clear the land of brush, to fill in gullies, and to construct brush dams to control erosion.

Table 207

GAINS SECURED PER ACRE OF IMPROVED PASTURE WHEN NO CONCENTRATES ARE FED*

Location	Kind of Forage	Period Grazed	Days Grazed	Gains per Acre pounds
Central Missouri	Bluegrass	May 6–Sept. 27	144	216
(Columbia)	Bluegrass-lespedeza	May 6–Sept. 27	144	279
Northwest Missouri	Wheat-lespedeza	Apr. 21–June 26		
(Lathrop)		July 27–Aug. 31	91	313
	Bluegrass-sweet clover	Apr. 27–Oct. 4	160	315
	Bluegrass-ladino	Apr. 27–Oct. 4	160	359
Northwest Indiana	Alfalfa-timothy	May 5–Oct. 14	162	264
(Upland)	Bluegrass	May 5–Oct. 14	162	198
Central Illinois	Bluegrass			160
(Urbana)	Bluegrass-ladino	Apr. 15–Sept. 20	158	329
	Brome grass-ladino	Apr. 15–Sept. 20	159	304
	Brome grass-alfalfa	Apr. 13–Nov. 1	202	342
	Alfalfa	May 6–Sept. 23	140	383
	Sweet clover, 2nd year	May 6–Aug. 2	88	220
	Haas mixture, 2nd year	Apr. 30–Nov. 1	185	416
Southern Illinois	Basic mixture†	Apr. 20–Nov. 25	219	277
(Dixon Springs)	Basic mixture + alta fescue	Apr. 20–Nov. 24	218	325
	Basic mixture + brome grass	Apr. 20–Nov. 24	218	364
	Basic mixture + orchard grass	Apr. 20–Nov. 24	218	337
	Basic mixture + bluegrass	Apr. 20–Nov. 24	218	296
	Ladino, timothy, red clover, alta fescue		...	564‡
Florida (Everglades)	St. Augustine grass		365	1,004

* Source of data: mimeographed reports of state experiment stations.
† Basic mixture (pounds per acre): ladino 1, timothy 4, red top 3, alfalfa 4, lespedeza 5.
‡ Three-year average, combined gains of cattle and sheep.

Better Methods of Utilizing Pasture. Many different methods of utilizing pastures in the finishing of cattle are in use, each of which probably has more or less merit for a given situation. Farmers who have a considerable area of pasture land do well to study critically their present use of pastures, since pastures can easily be more of a liability than an asset in beef production. In fact, a cattleman of much experience and a close observer of other feeders' methods once made the statement that "inexperienced feeders have lost more money trying to use pastures to save a little feed than pastures have ever made for those few feeders who know how to use them wisely." This is an excellent statement of the situation and emphasizes the fact that summer-feeding cattle on pasture is in many respects a more difficult task than winter-feeding in the dry lot in so far as profits are concerned.

Apparently one common error in the management of pastures is an attempt to use the available pasture in a cattle-feeding enterprise

that would succeed as well or even better without it, instead of adopting a plan of feeding that seems to offer the best opportunity to use the pasture efficiently. This practice is merely another instance of the necessity of fitting the cattle-feeding program to the available feed supply.

Cattle that are full-fed grain on pasture throughout the spring and summer use too small an amount of grass to make this plan of feeding satisfactory from the standpoint of utilizing comparatively large areas of pasture. If the pasture is stocked sufficiently heavily to consume most of the grass, that is, 2 to 3 head per acre, the number of cattle required may be greater than the supply of corn available on the farm will finish satisfactorily.

A study of the monthly gains of cattle on pastures given in Table 204 discloses that pasture is at its best in spring and early summer. Consequently it should be utilized at this time if the greatest returns are to be realized from a given area. To stock a pasture in the spring with only the number of cattle that it will carry through the entire season with average weather conditions is to permit a great waste of forage through failure to harvest the grass when it is most valuable. Too heavy stocking at any time during the grazing season results in little or no gain, since all the available grass is used for maintenance and none for production. Consequently, the logical thing to do is to stock the pasture with the number of cattle that insure the consumption of the forage at about the rate it grows at that time of year. This means stocking the field fairly heavily at the beginning, perhaps 2 or more head to the acre, and removing animals from time to time to supplementary pastures or to the dry lot where they are put on a full feed of grain. This system of grazing has been used at the Illinois station with quite satisfactory results, as is shown by the fact that the gains from pasture alone have averaged 295 pounds an acre over a 5-year period. Harvesting a portion of the abundant early spring growth in the form of hay or silage is another practical means of balancing grass supply and cattle numbers.

Rotation Grazing. The dividing of a pasture into two or more small fields each of which is to be grazed in turn is frequently recommended. Such a plan of grazing has been successful on dairy farms where the cows normally are driven to and from the pasture twice daily. However, it has several disadvantages from the standpoint of the beef producer. Among them are (1) the expense of constructing extra fencing and providing water and shade, (2) the tendency of the pastures that are deferred in the spring to be coarse and unpalatable by the time they are needed, and (3) the slowness

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	Basic mixture + alta fescue	Apr. 20–Nov. 24	218	325
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	Basic mixture + orchard grass	Apr. 20–Nov. 24	218	337
	Basic mixture + bluegrass	Apr. 20–Nov. 24	218	296
	Ladino, timothy, red clover, alta fescue		...	364‡
Florida (Everglades)	St. Augustine grass		365	1,004

* Source of data: mimeographed reports of state experiment stations.
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Apparently one common error in the management of pastures is an attempt to use the available pasture in a cattle-feeding enterprise

Table 209

METHODS OF UTILIZING AN ALFALFA CROP THROUGH BEEF STEERS*

	Pasture Lots		Dry Lots	
	5-Day Rotation Grazing	Strip Grazing	Hay	Soilage
Number of steers	9	9	10	10
Days on test	132	132	132	132
Initial weight, lb.	550	565	574	532
Av. daily gain, lb.	1.79	1.64	1.45	1.73
Feed consumption per head per day				
As fed				
Alfalfa, lb.	.		21.4	69.0
Oat hay, lb.	4.7	4.9		3.9
Dry basis				
Alfalfa, lb.	.	. .	18.9	14.1
Oat hay, lb.	4.2	4.4		3.5
Dry matter per cwt. gain, lb.			1,303	1,017
Beef production per acre, lb.	689	739	856	1,080
Percentage of soiling	64	68	79	100
Percentage of rotational grazing	100	107	124	157

* *Journal of Animal Science*, Vol 15, p. 64 (1956).

moisture content. This fact is especially true of legume forages such as alfalfa and the clovers. Cattle turned onto such pastures when the forage is only a few inches high usually scour badly and make little if any gain. Indeed, they may even lose weight, unless they have been wintered on poor rations Much better results usually are secured if grazing is deferred until the plants have made a good growth of both roots and tops and have had time to store an appreciable amount of dry matter in the stems and leaves (See Table 210.)

The deferring of grazing in midsummer by removing the cattle from a closely grazed pasture and returning them, perhaps in smaller numbers, after the forage has made a good growth is an important phase of good cattle and pasture management.

The Kansas Plan of Utilizing Pasture. The Kansas Experiment Station has conducted extensive experiments on the utilization of pasture in finishing yearling cattle for market with particular reference to the bluestem pastures of that state. Although this grass differs somewhat from rotation pasture, results obtained at the Missouri, Nebraska, and Illinois stations, where the same methods of grazing

with which closely grazed pastures recover if the weather is unfavorable for the growth of forage. Experiments carried on at the Indiana station indicate that rotation grazing of permanent pastures on which only mineral fertilizers have been applied results in less than 5 per cent increase in production and therefore is unprofitable.[3] If the rotation grazing of permanent pastures is to be practiced, a carefully worked-out plan of fertilization with nitrogen should be followed, which will insure the quick recovery of the pastures after the cattle are removed. Rotation grazing may be used successfully with rye, alfalfa, ladino clover, Sudan grass, and other crops that normally produce a heavy second growth after they have been closely grazed. Table 208 illustrates the effect of type of pasture upón the advantage to be expected from rotation grazing.

Table 208

Effect of Rotation Grazing upon Cattle Gains per Acre*

Forage Grazed	Number of Years Averaged	Fertilizer Applied	Total Gains per Acre, pounds: Continuous Grazing	Rotation Grazing
Permanent bluegrass	6	Lime, P, and K	215	224
Alfalfa-timothy	5	Lime, P, and K	180	216

* Purdue University Agronomy Mimeograph, AY-35A.

Strip Grazing and Soilage. California studies reported in Table 209 give some interesting comparative data on different methods of harvesting an alfalfa crop through beef steers. The strip grazing was controlled by an electric wire so as to provide a 2- or 3-foot strip across the field once or twice daily. Although oat hay was fed to minimize the danger of bloat, one steer from the soilage lot was lost from this cause. In spite of the one death loss in the soilage lot, however, bloat was more of a problem in the pasture lots. Strip grazing of this sort, it should be mentioned, is quite commonly practiced in Great Britain and northern Europe where pasture utilization is highly developed.

Deferred Grazing. Many pastures are grazed so early in the spring that the grass has no opportunity to build up root reserves before the leaves, where the food nutrients are elaborated, are eaten off by the cattle in their search for a bite of green forage. The food value of early spring pasturage is low because of the very high

[3] Purdue University Agronomy Mimeograph, AY-11A.

2 pounds of legume hay, 1 pound of protein concentrate, and 4 to 5 pounds of shelled corn per head daily was found to be excellent for this purpose. Omitting the shelled corn from the winter ration was found to be advisable with heifer calves but not with steer calves, *since steers wintered only* on sorghum *silage and hay* lacked sufficient finish to sell satisfactorily the next fall.

2. Graze on pasture without grain for approximately 90 days, or May 1 to August 1. Although these were the limiting dates in all of the Kansas experiments, *results obtained at other stations indicate* that the condition of the pasture should be taken into consideration in deciding when to begin and end the grazing period. Obviously nothing is to be gained by leaving cattle on a pasture that does not furnish enough feed to insure reasonably good gains.

3. Full-feed in dry lot for 100 days, or approximately August 1 to November 15. Various other plans of feeding were tried, but none was found to be as satisfactory as this. Steers fed on pasture during the last 100 days did not gain as fast as those removed to the dry lot and then sold for a much lower price. Other plans involving various

Table 211

THE KANSAS METHOD OF UTILIZING PASTURE IN FINISHING YEARLING CATTLE*
Standard Plan: Winter well; graze 90 days; full-feed 100 days in dry lot

Comparison of Standard Plan with Variation Therefrom (3-yr. averages)	Winter Gain 136 days	Pasture Gain 90 days	Gain While Full-Fed Grain	Total Gain	Selling Price per Cwt.	Margin per Head	Corn-Fed per Head (bu.)
(1926–1929)							
Standard Plan	258	98	256	612	$14 92	$43.54	37
No corn fed in winter	183	123	263	569	14 58	40 54	26
(1929–1932)							
Standard Plan	270	91	285	646	9 00	11 76	39
Full-fed on pasture after May 1	*268*	. .	*283*	*551*	*8 83*	*.69*	*43*
Full-fed on pasture after Aug. 1	269	93	271	633	8 08	4.17	39
(1932–1936)							
Standard Plan	240	93	259	592	7.75	4 66	37
Fed 60 days on pasture after Aug 1; last 40 days in dry lot	236	93	250	579	7 42	3 01	37
(1933–1937)							
Standard Plan	231	90	265	586	10 35	10 17	38
Winter grain ration discontinued gradually during first 4 weeks on pasture	*229*	*104*	*256*	589	9 73	*5.87*	39
Winter grain ration continued on pasture	219	131	247	597	10 20	3 64	46

* Kansas Experiment Station Mimeographed Report.

Table 210

COMPARISON OF EARLY AND DEFERRED GRAZING*
(Yearling Steers)

Period	Days	Early Grazing (5 Acres) Number of Cattle	Area per Head	A. D. G.	Deferred Grazing (10 Acres) Number of Cattle	Area per Head	A. D. G.
Apr. 23–May 11	18	10	0.5	1 28	..	..	..
May 11–May 28	17	10	0 5	0 12	..	..	..
May 28–June 22	25	3	1.7	1.13	14	0.7	2.26
June 22–July 20	28	3	1.7	1.19	16	0.6	1.90
July 20–Aug. 17	28	3	1.7	1.07	16(4)[a]	0.6(2.5)	1.49
Aug. 17–Sept. 14	28	3	1.7	0 48	4	2.5	0.89
Sept. 14–Oct. 12	28	3	1 7	2.62	4	2.5	2.23
Oct. 12–Nov. 1	20	3	1 7	0	4	2.5	0.75
Total time grazed		172 days			157 days		
Total cattle days		821			1310		
Cattle days per acre		164			131		
Total gain		800 lb.			2360 lb.		
Av. daily gain		0 97			1.80		
Gain per acre		160			236		

* Illinois Mimeographed Report.
[a] Sixteen steers until July 28, and 4 steers thereafter.

have been used, are so similar to those obtained in Kansas as to leave little doubt that the plan of grazing recommended by the Kansas station is well suited to all pasture forages that produce their heaviest growth in the spring and early summer.

The object of the Kansas experiments was to determine the best method of using pasture in the finishing of beef calves purchased in the fall and marketed approximately a year later as fed yearlings. Some of the different methods of feeding and grazing used are shown in Table 211. The following plan almost always proved to be the most profitable:

1. Steer calves wintered sufficiently well to gain 1.3 to 1.5 pounds a day. A ration consisting of 16 to 20 pounds of Atlas sorgo silage,

Table 212

THE MISSOURI PLAN OF UTILIZING PASTURE IN PRODUCING FINISHED YEARLING AND 2-YEAR-OLD STEERS*

	Fat Yearlings[a]			Fat 2-Year-Olds[b]		
	Length of Period, days	Gains, pounds	Percentage of Total	Length of Period, days	Gains, pounds	Percentage of Total Gains
Initial weight		(577)	..		(430)	
Gain: 1st winter	140	167	29	127	130	15.6
1st summer	170	225	39	221	282	33 8
2nd winter	.	..	..	125	110	13 2
2nd summer	..	.	..	169	201	24 1
Full fed in dry lot	84	185	32	51	111	13 3
Total	394	577	100	693	834	100 0
Final weight, pounds		1154			1264	
Av. corn fed, bushels		25 3			17 2	
Wt. of live cattle produced per bushel of corn fed, pounds[c]		45			73	

* Missouri Livestock Feeders' Day Progress Reports 7 and 10
[a] Average of 2 years.
[b] Average of six lots
[c] Not including corn in silage

legume hay, 45 per cent in the summer on pasture, and 25 per cent during the finishing period in dry lot. The cost of gains has been remarkably low.

Some of the cattle in the Missouri experiments have been carried over the second winter, grazed the following summer, and sold in the fall as 2-year-olds after a feeding period of only 6 or 8 weeks Approximately 85 per cent of the 825–850 pounds of total gain has been made from roughages and pasture, and only 15 per cent from the corn and hay fed in the dry lot. (See Table 212.)

The Dixon Springs Plan. The University of Illinois, at the Dixon Springs station located in the badly eroded hilly area in the southern part of the state, has compared several methods of utilizing pastures with home-bred calves One plan, which has given excellent results, differs from the Kansas plan only with respect to the finishing period

combinations of pasture and dry-lot feeding were also inferior to the standard method.

As stated above, the Kansas plan of using pastures has been successfully used at the Nebraska, Missouri, and Illinois stations. Its chief points are: (1) the cattle are wintered in such a way as to make them able to use pasture efficiently the following summer; (2) the grass is grazed at the stage of growth when it is most palatable and nutritious; (3) when the productive season of the pasture is over the cattle are removed to the dry lot and full-fed for the late fall market, which usually is a good season to market grain-fed yearling steers of good quality.

The Missouri Plan. Many valuable grazing experiments have been carried out at the Missouri station to compare different methods of utilizing the pastures of that state. The plan found to be most satisfactory differs from the Kansas plan principally in the kind of pastures used and in the length of the finishing period in dry lot. Fall-sown wheat, bluegrass, and lespedeza pastures, usually grazed in that order, have provided good grazing from about April 15 until October 1, or for 5½ months. As a result of the long grazing season the period of dry-lot feeding has often been reduced to 60 or 70 days. Usually 550 to 600 pounds of gain are made by each steer, which is fed 20 to 30 bushels of corn, excluding the corn in the silage. About 30 per cent of the total gain is made during the winter on silage and

FIG. 87. Good grade stockers on grass without grain. Such steers would be ideal for a heavy feed of corn silage followed by a short feed of grain. (American Hereford Association.)

Table 214

STEER MANAGEMENT PROGRAMS UTILIZING CROPS PRODUCED N TYPICAL CORN BELT ROTATION CROPPING SYSTEMS*

	Calves		Light Yearlings
	1953–54	1954–55	1955–56
Days on test	354	357	371
Av. pay weight, lb.	436	476	559
Laid down price/cwt., $	20.68	23.43	22.13
Adjustment and gleaning phase	11/6–12/2 25 days	10/28–11/17 21 days	9/7–11/7 78 days
Ration	mixed hay	mixed hay	new seeding, corn stalks
Av. final wt., lb.	435	476	654
Av. daily gain	recovered shrink	recovered shrink	1.22 lb.
Investment per cwt. steer to date, $	21.33	23.84	21 00
Wintering phase	12/2–4/14 133 days	11/17–4/21 154 days	11/17–5/8 173 days
Ration	oat silage hay 3 5 lb gr. shelled corn	oat silage hay 3 0 lb. concentrate	oat silage hay 2 0 lb. gr shelled corn
Av. final wt., lb.	666	668	849
Av. daily gain, lb.	1.74	1.24	1.13
Investment per cwt. to date, $	18.42	21.18	20 53
Full-fed on pasture phase	4/14–9/1 140 days	4/21–8/25 126 days	5/8–9/13 128 days
Ration	pasture gr. ear corn prot. concentrate	pasture gr. ear corn prot. concentrate	pasture gr ear corn prot. concentrate
Stocking rate	3 head/acre	3 head/acre	3 head/acre
Av. final wt., lb.	945	986	1,131
Av. daily gain, lb.	2.00	2 52	2 24
Investment per cwt steer to date, $	18 64	20 03	18 58
Final dry lot phase	9/1–10/27 42 days	8/25–10/20 56 days	
Ration	gr. ear corn hay prot. concentrate	gr. shelled corn hay prot. concentrate	
Av. final wt., lb.	1,065	1,093	1,131
Av. daily gain, lb.	2.15	2 02	
Investment per cwt steer to date,† $	19.10	21.67	19 81

* Illinois Mimeographed Reports, 1954, 1955, 1956.

† Based on final weight, shrunk by 4%, and a marketing cost of $5 per head. Feed prices used were: corn, $1.26 per bu.; hay, $20 per ton; protein concentrate, $80 per ton; oat silage, $7.50 per ton.

during the late summer and fall. At the Dixon Springs station both yearling and 2-year-old steers are full fed on late summer and fall pasture, whereas at the Kansas station they are fed in dry lot. Lespedeza and ladino clover, either alone or in mixed seedings, are excellent forages during August, September, and October, and their value would not be utilized if they were not grazed heavily during these months.

Yearling and 2-year-old steers which were marketed directly from pasture in October without being fed any grain have also been included in the Dixon Springs tests. The younger cattle have usually

Table 213

METHODS OF UTILIZING PASTURES AT THE DIXON SPRINGS EXPERIMENT STATION IN SOUTHERN ILLINOIS*

	Sold as Yearlings				Sold as 2-Year-Olds			
	Full Fed 100 Days on Pasture		Sold Directly Off Pasture		Full Fed 94 Days on Pasture		Sold Directly Off Pasture	
	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage

chapter **23**

HORMONES AND MISCELLANEOUS RATION ADDITIVES

Rations consisting only of natural feedstuffs, both harvested feeds and pasturage, can be quite efficiently converted to animal gains when properly combined. Rates of gain which were considered normal a decade or so ago can be made on such rations without the addition of complex supplements or feed additives. Recent developments in physiology and ruminant nutrition, however, are causing the gain and feed conversion figures of a decade ago to become obsolete. Progressive feeders today would not think of feeding cattle without taking advantage of the stimulus supplied by certain of the ration additives or treatments discovered through recent research. Some of these new developments are so recent as to require further testing before recommendations can be made concerning their use. Those which have been quite thoroughly tested are discussed below.

Hormones. The greatest development in beef cattle feeding and management since the establishment of the need for protein supplementation is the development of practical methods of utilizing synthetic or manufactured hormone-like compounds.

Diethylstilbestrol, generally referred to as stilbestrol, is a synthetic estrogen-like compound which has many of the physiological properties of the female sex hormones. It is the most important of the hormone or hormone-like materials currently in use. Its action on the animal body is similar to that of the natural sex hormones, both male and female, in several respects. First, growth is stimulated in immature animals. This growth, as growth nearly always is, is accompanied by economically important improved feed conversion. The increased growth results in a corresponding increase in the protein or lean meat content of the animal or carcass, with a corresponding lessening of external fat content or rind. A second effect of the use of diethylstilbestrol is that certain side effects or secondary sex characteristics develop in the animal which may detract from the on-foot evaluation of the live animal. These side effects are more

Table 215

SUMMARY OF STILBESTROL CATTLE FEEDING EXPERIMENTS CONDUCTED AT NINE AGRICULTURAL EXPERIMENT STATIONS*

College Station Where Experiments Were Conducted	Kind of Cattle	Type of Ration	No. of Cattle		Av. Daily Gain		% Increase	Feed Saved Due to Stilbestrol, %	No. Days on Experiment
			Check Lot	Stilbestrol	Check Lot	Stilbestrol			
Iowa AH 188 (1954)	steers	grain	8	16	2.13	2.67	25	13	43
Iowa AH 189 (1954)	steers	grain	8	24	2.23	2.72	22	12	112
Iowa AH 192 (1954)	heifers	grain	8	16	2 03	2.29	13	13	113
Iowa FSR 107 (1954)	steers	roughage	20	20	1.10	1.21	10	10	127
Iowa AH 193 (1954)	steers	½ and ½	8	8	1.71	1.99	16	11	243
Iowa AH 194 (1954)	steers	grain	8	14	2.36	2 53	8	7	120
Iowa July (1955)	steers	roughage	40	40	1.00	1 08	8	8	119
Iowa July (1955)	calves	grain	9	18	2 22	2.45	10	6	224
Colo. No. 605 (1955)	steers	grain	9	8	2 30	2.90	26	21	84
Kan. No. 320 (1955)	calves	roughage	20	20	1.91	1.90	0	0	140
Kan. No. 320 (1955)	calves	roughage	5	5	1.72	1.82	6	6	140
Mich. June (1955)	steers	grain	14	14	2.30	2.60	13	20	98
Neb. 71 (1955)	steers	grain	15	15	2.02	2.40	19	12	112
Ohio No 94 (1955)	steers	grain	21	21	2.17	2.47	14	13	84
Purdue 139 (1955)	steers	grain	10	10	2.33	2.64	13	11	123
Purdue 148 (1955)	steers	grain	9	9	2.71	3.30	21	18	98
Purdue 149 (1955)	calves	grain	9	9	2.37	2 84	20	15	98
Tenn. (1955)	steers	grain	24	16	1.38	1.77	28	18	98
Texas April (1955)	steers	grain	10	10	2.38	3 03	27	11	120
Av. all experiments			255 total	293 total			16%	12%	

* Iowa AH 693, 1955

evident in the early stages of the feeding period and may completely disappear by the time the feeder cattle are ready for market. The most common side effects are depressed loins, raised tailheads and rumps, and enlarged teats in both steers and heifers. In addition, heifers are likely to be affected with vaginal prolapse, which may occur in as many as 25 per cent of the heifers receiving "stilbestrol."

Oral Use of Stilbestrol. The use of stilbestrol in cattle rations was approved by the Food and Drug Administration in 1954, with the level of administration being set at 10 mg. daily. Stilbestrol may be administered either by implanting pellets under the skin, or by oral administration—that is, feeding. The Iowa station has made extensive tests of the latter method of using stilbestrol and at the present time this is the more popular of the two. The Iowa tests and others are summarized in Table 215. The data show that rate of gain was stimulated to a greater degree with high-grain rations than with high-roughage rations, and stimulation was greater in steers than in heifers and greater in heavy cattle than in light or young cattle. In all of the tests summarized, stilbestrol increased gains by an average of 16 per cent and reduced feed requirements by an average of 12 per cent. Carcass grades were not seriously reduced nor were dressing percentages affected.

Stilbestrol for oral use is mixed with protein supplements by commercial feed manufacturers in such amounts that 1 pound of supplement contains either 5 or 10 mg. of stilbestrol. Thus, if it is desired to feed 10 mg. of stilbestrol daily, the feeder can feed either 1 pound of the 10-mg. supplement or 2 pounds of the 5-mg. supplement.

Implanting Stilbestrol. The Food and Drug Administration in 1955 approved the use of ear-implant stilbestrol pellets for cattle. The pellets most commonly used contain 12 mg. of stilbestrol each. Twelve to 48 mg., or 1 to 4 pellets, are usually used in a single treatment, depending on the age and size of the animal. The pellets are implanted under the skin on the back side of the ear near the head so as to avoid any chance of residual or unabsorbed stilbestrol being left attached to the carcass proper. (In the usual packing house slaughter procedure the ear is left on the hide.)

Table 216 gives data from a typical test which illustrates that oral and implanted stilbestrol are equally effective in increasing gains and improving feed efficiency. The slightly lower carcass grade for the implanted steers was undoubtedly due to the rather high level (60 mg.) of stilbestrol used.

Effect of Type of Ration on Response to Hormones. Since the response to stilbestrol is in the nature of growth, it is not surprising

Table 218

EFFECT OF ORAL AND IMPLANTED STILBESTROL ON PERFORMANCE OF STEERS FULL-FED ON LEGUME-GRASS PASTURE (125 days)*

Stilbestrol Treatment	Av. Daily Gain (lb.)	Increase (%)	Feed/100 lb. Gain†	Feed Saved (%)
None	2.71	. .	451	. . .
10 mg. orally	2.56	−5.5	482	−7
24 mg. implant	3.07	+13.3	402	+11
36 mg. implant	3.19	+17.7	387	+14

* Purdue Mimeographed AH 194, 1957.

† Steers consumed an average of 10.78 lb. ground ear corn and 1.56 lb. Purdue Supplement A daily.

to stilbestrol. This variation can be explained by the fact that it has been found that certain pasture forages, especially legumes, contain varying amounts of estrogenic or hormone activity in themselves. Here, too, level of energy or type and amount of grain consumed in addition to the pasture forage can, and does, affect the response to stilbestrol. Table 218 shows the results of an Indiana test in which both methods of using stilbestrol were practiced. Implants of 24 or 36 mg. of stilbestrol produced significant responses in gain and feed conversion, while orally administered stilbestrol failed to improve performance.

Data in Table 219 are the result of one of several experiments conducted at the Ohio station which illustrate the importance of meeting the protein requirements of feeder cattle if maximum benefit

Table 219

*EFFECT OF LEVEL OF PROTEIN IN THE FINISHING RATION UPON RESPONSE TO STILBESTROL**

Per Cent Total Protein in Ration	*Average Daily Gain (lb.)* Control	Stilbestrol	Response (lb.)
8.27	1.75	1.78	0.03
9.46	1.79	2.02	0.23
9.66	2.06	2.42	0.36
11.09	2.10	2.61	0.51
11.24	2.10	2.53	0.43
12.87	2.28	2.44	0.16

* Ohio Research Bulletin 802, 1958

Table 221

EFFECT OF PREVIOUS STILBESTROL IMPLANTATION ON THE PERFORMANCE OF YEARLING STEERS IN THE FEED LOT (150 days)*

	Controls	Implanted in May with 36 mg. Stilbestrol
Number of steers per group	*30*	*30*
Average weights, lb.		
Initial 9/27/57	725	757
At 83 days	968	1,003
Daily gain to 83 days	2.93	2.96
At 150 days	*1,082*	*1,093*
Daily gain from start to 150 days	2.38	2.24
Average daily ration, lb.		
Sorghum silage	46.0	46.0
Ground milo	10.0	10.0
Supplement†	*1.7*	*1.7*
Salt	0.07	0.07

* Oklahoma Cattle Feeders Report, 1958.
† Supplement consisted of soybean meal, urea, dried molasses, calcium carbonate, monosodium phosphate, and sufficient stilbestrol premix to supply 10 mg. stilbestrol per steer daily.

stilbestrol, as shown in Table 222. It may also be seen that heifers may respond differently than steers. In both sexes, noticeable side effects were present which would tend to lower the selling prices of the weaned calves.

The calves just discussed were full-fed finishing rations containing 10 mg. stilbestrol daily for 155 days after a 3-week post-weaning adjustment period. Table 223 shows that the steer calves which were previously implanted as suckling calves gained more slowly and less economically than the steer calves which had received no previous implant. These results are similar to the situation observed with the yearling steers that had been previously implanted on grass (see Table 221). The heifer calves, on the other hand, responded to the oral stilbestrol in the finishing ration even though they were previously implanted. The explanation for this sex difference is not yet clear.

Effect of Stilbestrol on Carcass Yield and Grade. Extensive tests were conducted at the Ohio station to determine the effect of stilbestrol upon carcass yield and grade. Results are summarized in Table 224. In these tests dressing percentage was not affected but

is to be derived from the use of stilbestrol. At the same time it can be seen that feeding more than the required level of protein does not further increase gains.

Effect of Previous Use of Stilbestrol on Feedlot Performance. As soon as it was well established that it was profitable to use implanted stilbestrol in stocker steers that were grazing summer pasture, ranchers began to employ it. A logical question in the minds of cattle feeders who would subsequently feed such implanted steers was, could further responses be expected from stilbestrol in the feed lot? Table 220 shows the response to stilbestrol implantation of steers on grass alone, or on grass plus a salt-controlled self-fed milo supplement. After the summer grazing season the steers were full-fed for 150 days in dry lot with all steers receiving 10 mg. of stilbestrol daily.

Table 221 shows that the previously implanted steers gained more slowly than those not treated while they were on pasture during the previous summer. In fact, 65 per cent, or 21 of the 32 pounds of extra summer gain resulting from implantation were lost in the feedlot period. This subject is being vigorously studied at this time, since it is of extreme importance to both the cow-and-calf and the cattle-finishing programs. The situation may be different with previously implanted weanling calves than with previously treated yearling steers with respect to subsequent performance in the feed lot. Added gain can usually be expected from implanting suckling calves with

Table 220

Effect of Stilbestrol Implantation on Gains of Steers Grazing Native Grass*

Supplemental Feed	None†	None†	Salt-Milo‡	Salt-Milo‡
Stilbestrol	None	36 mg. Implant	None	36 mg. Implant
Number of steers per lot	15	15	15	15
Average weight per steer, lb.				
Initial 5/20/57	563	565	565	563
Final 9/4/57	757	786	767	786
Gain (107 days)	194	221	202	223
Daily gain	1.81	2.07	1.89	2.08
Av. daily supplemental milo, lb.	...	...	2.51	3.44
Cost of milo per steer, $	. .	...	6.70	9.20

* Oklahoma Feeders Day Report, 1958.
† Salt was available ad lib.
‡ Self-fed a mixture of salt and ground milo. Average salt content was 10.5%.

It may be safely estimated that at least 75 per cent of all feeder cattle now receive hormones or hormone-like materials in one form or another.

Antibiotics. The encouraging results obtained with the use of antibiotics in swine and poultry rations led investigators to study the use of these additives in beef cattle rations. Because early work with antibiotics for dairy calves infected with digestive disturbances of bacterial origin appeared promising, it was natural that tests would be made with suckling beef calves. Table 225 shows the favorable results obtained in two such tests in which aureomycin was used. Many tests in other herds were negative, however, so it appears that disease level and sanitation practices determine whether favorable responses can be expected from antibiotics being fed to suckling calves.

The continuous feeding of either aureomycin or terramycin in the roughage rations of stocker cattle has produced variable results, just as with suckling calves. Calves infected with shipping fever after transport from range to feed lot can generally be expected to respond

Table 223

EFFECT OF PREVIOUS IMPLANTATION AS SUCKLING CALVES ON SUBSEQUENT FEEDLOT PERFORMANCE*

	Controls	Previously Implanted
Heifers		
Number compared	10	10
Av. weights, lb.		
Initial	491	502
Final	806	848
Av. daily gain	1.98	2 18
Feed cost per cwt., $	19.72	17.91
Appraised value per cwt., $	27.25	26.78
Net return over heifer + feed cost, $	45.41	50.33
Steers		
Number compared	14	14
Av. weights, lb.		
Initial	478	529
Final	829	872
Av. daily gain	2.21	2.18
Feed cost per cwt gain, $	17.66	18 15
Appraised value per cwt , $	26 65	27 19
Net return over steer + feed cost, $	35 31	38 25

*Oklahoma Cattle Feeders Report, 1958.

Table 222

EFFECT OF IMPLANTING TWO 12-MG. PELLETS OF STILBESTROL IN SUCKLING CALVES NOT CREEP-FED*

	Control	Stilbestrol Implanted
Fort Reno trial (123 days)		
Number of calves	13	14
Steers	4	5
Heifers	9	9
Av. age at first implant, days†	82	80
Av. gain to weaning, lb.	208	232
Steers	229	230
Heifers	199	233
Lake Blackwell trial (137 days)		
Number of calves	15	15
Steers	8	9
Heifers	7	6
Av. age at first implant, days†	106	97
Av. gain to weaning, lb.	245	293
Steers	244	297
Heifers	246	286

* Oklahoma Cattle Feeders Report, 1958.

† Implanted twice with 12 mg. stilbestrol each time; second implant approximately 75 days after first.

carcass grade was slightly reduced. The reduction in grade was due to a noticeable lack of marbling in cattle fed or implanted with stilbestrol, as compared with non-treated cattle fed a similar period of time. Measurements of the area of the cut surface of the rib-eye showed that more lean meat was actually present in the carcasses of stilbestrol-treated cattle. However, so long as marbling plays such an important part in determining carcass grade, stilbestrol-treated cattle will be downgraded A solution to this problem is simply a matter of feeding to heavier weights with a longer feed if necessary. In other words, stilbestrol should be used to produce somewhat heavier cattle at lower feed costs, rather than to shorten the length of the feeding period.

Other hormones and hormone-like materials which show results comparable to those of stilbestrol are hexestrol, dienestrol, estradiol-progesterone combinations, and others. Newer materials are being tested in the experimental feed lots and others are awaiting testing.

Table 225

*Effect of Aureomycin on Gains of Suckling Beef Calves**

	First Trial		Second Trial	
Aureomycin (daily)	0	24 mg./100 lb. body wt.	0	20 mg./ calf
Number calves	7	6	7	8
Av. initial weight, lb.	61	60	61	64
Av. 80-day weight, lb.	188	203	146	157
Av. daily gain, lb.	1.59	1.78	1.46	1.60
Incidence of scouring, days	38	7	. .	. .

* Indiana Cattle Feeders Reports, 1953 and 1954.

to continuous feeding of 40 to 80 milligrams of antibiotic daily. Native weanling calves and yearlings, being less subject to shipping fever, generally do not respond to antibiotic feeding.

If anything, results have been even more inconsistent with finishing rations. The Indiana test summarized in Table 226 shows how gains were increased in their tests by additions to a finishing ration of either antibiotic alone or a combination of antibiotic and hormones.

The Illinois test reported in Table 227 is typical of the tests in which no response was obtained from the use of an antibiotic, whether or not stilbestrol was used and whether the cattle were limited or full-fed.

Because the response to antibiotics is so inconsistent as far as feeder cattle are concerned, the use of this ration additive must remain in the questionable category.

Tranquilizers. Both natural and synthetic tranquilizing drugs have been used by the medical and veterinary professions to treat patients in order to reduce hypertension and nervousness. Research workers are now exploring the possibility of including these drugs at extremely low levels in the rations fed to farm animals. Although Food and Drug Administration approval has been given for only one such drug, their use may become as commonplace as that of stilbestrol if further research substantiates that reported in Table 228. The rauwolfia used is a natural alkaloid prepared from the rauwolfia plant found in India, whereas hydroxyzine is a synthetic diphenylmethane derivative. Further study is under way concerning the possibility of residual material being retained in the carcass, a point which must

Table 224

SUMMARY OF CARCASS YIELD AND GRADE OF CONTROL AND STILBESTROL TREATED BULLS, STEERS AND HEIFERS*

	Number of Animals		Dressing Percentage		Carcass Grade†	
Experiment	Control	Stilbestrol	Control	Stilbestrol	Control	Stilbestrol
Bulls						
1952–1953	10	5	58.8	59.6	2.01	1.64
1953–1954	10	10	61.2	61.6	2.47	2.03
1954–1955	12	12	61.9	61.3	1.97	1.91
Total	32	27	181.9	182.5	6.45	5.58
Average			60.6	60.8	2.15	1.86
Steers						
1953–1954	10	9	61.5	61.3	1.37	1.62
1954–1955	12	12	61.7	60.6	1.20	1.25
1954–1955	7	7	60.3	62.3	1.61	1.06
		7‡		59.3		1.66
	7	7	62.3	60.8	1.43	1.71
		7‡		61.5		1.61
	7	7	62.3	62.7	1.34	1.40
		7‡		61.4		1.23
1955–1956	7	7	61.5	59.4	1.99	2.36
	7	7	62.3	60.6	1.51	1.94
	7	7	61.9	61.3	1.57	1.89
1955–1956	10	10	61.7	61.6	1.20	1.59
		10‡		61.5		1.68
1955–1956	9	8	61.5	62.5	1.39	1.55
	8	8	61.4	61.8	1.60	2.10
1954	11	10	57.7	58.9	2.43	2.45
1955	10	10	58.2	58.6	2.00	2.30
1956	12	11	56.8	56.8	1.97	2.15
Total	124	151	851.1	1,092.9	22.61	32.54
Average			60.8	60.7	1.62	1.81
Heifers						
1955–1956	8	8	60.8	62.5	1.60	1.52
	8	8	60.9	62.3	1.72	1.60
Total	16	16	121.7	121.8	3.32	3.12
Average			60.8	62.4	1.66	1.56
Grand total	172	194	1,154.7	1,400.2	32.38	41.24
Grand average			60.8	60.9	1.70	1.79

* Ohio Research Bulletin 802, 1958

† Carcass grade factors High, average and low good = 2.0, 2.4, 2.7.
High, average and low choice = 1.0, 1.4, 1.7

‡ Stilbestrol fed, all others implanted

always be thoroughly explored before the inclusion of non-feed additives in livestock rations is legalized by the Food and Drug Administration.

Just as is the situation with hormones and antibiotics, literally hundreds of new and still untested sedative compounds can be found on the shelves of the pharmaceutical manufacturers. The cattle feeder has the problem of keeping abreast of the latest discoveries in this fast-moving field of feed additives. Perhaps the adage "be not the first to try the new nor yet the last to throw away the old" is applicable here, since preliminary reported data are sometimes misleading.

Goiterogens. Goiterogens such as thiouracil, thiourea, and "methimazole" are compounds which also are reported to produce a quieting effect on cattle. This effect is the result of their depressing action upon the thyroid gland, resulting in a "hypothyroid" condition. Unfortunately, in most controlled experiments, appetite was reduced to the extent that subnormal performance resulted. Recent work at Iowa has stimulated research in this field and new findings yet to come may add the compounds with goiterogenic activity to the growing list of ration additives.

Dried Rumen Contents. Veterinarians have used rumen contents, prepared by special drying procedures which supposedly do not destroy the rumen microorganisms, to bring cattle back on feed which have been ill or badly off feed because of digestive system infection or other rumen disorders. Heavy use of sulfa drugs or antibiotics in the treatment of rumen disorders reduces the normal microflora of the rumen to abnormally low levels and thus the treatment with specially prepared rumen contents sometimes produces favorable results by more quickly re-establishing normal rumen microflora. Although many cattle feeders have been adding such materials to the rations of healthy cattle at considerable cost, experimental evidence does not justify this ration additive under normal circumstances.

Yeast. From time to time, yeasts of various forms are highly advertised as very valuable ration additives. Research with yeast as a cattle feed is extensive, with recent work by the Iowa and Ohio stations again showing that yeast does not serve an essential function in cattle rations.

The principal value of yeast as a feed for cattle lies in its high protein content, which is approximately 50 per cent. Consequently it may replace soybean oil meal, cottonseed meal, or other high-protein supplements on a pound-for-pound basis. As a protein source, yeast cannot compete from an economic standpoint.

Table 226

EFFECT OF ANTIBIOTIC AND ANTIBIOTIC-HORMONE COMBINATIONS ON THE GROWTH AND FATTENING OF YEARLING STEERS*
(161 days)

Treatment	Lot I No Antibiotic or Hormone	Lot II Aureomycin†	Lot III Aureomycin and Stilbestrol‡	Lot IV Aureomycin and Hexestrol‡	Lot V Terramycin	Lot VI Terramycin and Stilbestrol	Lot VII Terramycin and Hexestrol
Steers per lot	12	12	12	12	12	12	12
Av. initial wt., lb.	635	630	632	634	631	637	630
Av. final wt., lb.	987	1,012	1,050	1,038	1,008	1,020	1,030
Gain per steer, lb.	352	382	418	404	377	383	400
Av. daily gain, lb.	2.19	2.38	2.60	2.51	2.34	2.38	2.48
Increase in gain, %		8.6	18 8	14.7	7.2	8.8	13.6
Average Daily Feed							
Corn silage, lb.	43.2	45.4	46.7	47.4	45.1	46.8	46 1
Supplement, lb.	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Mineral, lb.	0.05	0.05	0 05	0.04	0.04	0.04	0.05
Salt, lb.	0.03	0.03	0.03	0 02	0.02	0.02	0.02
Feed per Lb. Gain							
Corn silage, lb.	19.8	19.1	18.0	18.9	19.3	19.7	18.6
Supplement, lb.	1.6	1.5	1.4	1.4	1.5	1.5	1.4
Feed saved, %		3.7	9.6	5.1	2.9	1.1	6.5
Feed cost per cwt. gain,§ $	16.20	15.70	14.80	15.50	15.90	16.20	15.40

* Indiana Cattle Feeders Day Report, 1956.
† 80 mg. daily.
‡ 10 mg. daily.
§ Feed prices: Corn silage, $9 80 per ton; "Supplement A," $80 per ton; stilbestrol or hexestrol, 50¢ per gm.; aureomycin or terramycin, 11¢ per gm.; bonemeal, $4.50 per cwt.; salt, $1.60 per cwt.

Implanted Steers Limited-Fed on Pasture*

Pasture, No Antibiotic			Dry Lot		
Hormone‡		No Hormone	Hormone‡		No Hormone
4		5	4		5
850		834	850		869
1,015		926	1 025		1,040
2.62		1.46	2.78		2.71
	1.98			*2 75*	
6		6	15.3		15.3
...		...	.		
...		...	5		5
	9.43			*13 06*	
1,015		926	1,025		1,040
1,190		1,074	1,175		1,152
2.73		2 31	2.34		1.75
	2.50			*2.05*	
15.7		15.7	15 4		15.4
.		.			.
.		. .	5		5
	15.44			*18.65*	
2.66		1.88	2 54		2 21
	2.22			*2.30*	
	12.82			*15.42*	

‡ Implanted with 36 mg. stilbestrol.
§ Mix: 10 parts ground ear corn; 1 part soybean oil meal

chiefly strychnine. Since both these drugs are highly poisonous their stimulating effect is achieved by their powerful reactions on the metabolic systems. Obviously the dosage must be gauged very carefully or an acute toxemia is produced which may result in death

Yearling heifers fed nux vomica and arsenic trioxide at the Washington station showed no more avid appetites than the control heifers but made somewhat larger daily gains However, when the feeding

part IV

SPECIALIZED BEEF-CATTLE PROGRAMS

Table 228

EFFECT OF HYDROXYZINE AND RAUWOLFIA ON FULL-FED STEERS*
(All lots received terramycin and stilbestrol—110 days)

Treatment	Daily Gain lb.	Feed/lb. Gain lb.
Control	2.88	8.57
Hydroxyzine, 2.4 mg. daily	3.13	8.16
Rauwolfia, 25 mg. daily	3.25	8.24

* Sherman et al., *Journal of Animal Science*, Vol. 16, p. 1020, 1957.

of arsenic trioxide was discontinued the rate of gain dropped from 2.24 to 1.41 pounds per day, despite the fact that the daily feed consumption did not change significantly during this period.[1] Such behavior in cattle after stopping the feeding of these highly stimulating drugs has been noted frequently by practical cattlemen.

It is commonly believed that the feeding of Fowler's solution, and perhaps nux vomica as well, to cattle in appreciable amounts or over long periods adversely affects their fertility. Consequently the use of such drugs is regarded as a dishonest and unethical practice and is strongly condemned.

[1] *Journal of Animal Science*, August, 1949, pp. 411–424.

chapter **24**

THE BABY-BEEF AND FAT-CALF PROGRAMS

The western and southwestern range areas are usually associated with beef cows, as has been previously discussed in connection with sources of stocker and feeder cattle. Most of the calves and yearlings produced in the range areas are sold to cattle feeders for further development and finally for finishing for the butcher. It has also previously been mentioned that beef cows are found throughout the country in ever-increasing numbers, and that the Corn Belt and southeastern states are showing especially large increases.

Cattlemen in the non-range areas who manage and handle their cows with the view of producing stocker and feeder calves and yearlings to sell to cattle feeders, in direct competition with the ranchers in the range states, are not making full use of all the opportunities available to the non-range area cow-and-calf man. In the Corn Belt states, and in much of the rest of the non-range area for that matter, grain and harvested roughage are produced on every farm. Markets for fed cattle of all weights and grades are nearby and, in the Southeast and South particularly, weather conditions permit fall and winter calving with a minimum of shelter. Winter small grains, ideal for nursing beef cows, are being grown more extensively.

Feeding out one's own home-raised beef calves offers the cow-and-calf man with considerable pasture and varying amounts of harvested roughage and grain a real opportunity to increase the size of his business. Two specialized programs of raising and feeding out the home-raised feeders which are proving profitable are the baby-beef and the fat-calf programs. Their principal difference lies in the age and weight at which the slaughter calves are sold and in the beef characteristics found in the cow herds. Both programs call for maximum growth rate from birth to market to the extent that the calves "never have a hungry day in their lives," as someone has said.

Generally speaking the baby-beef program is more suitable for the heavier grain-growing areas, whereas the fat-calf program is better

or better grade of the major beef breeds with pure or nearly pure breeding should be used if the baby-beef program is to succeed. By all means, cows showing much dairy breeding should be avoided. Such cows are better utilized in a fat-calf program, as will be further elaborated upon. Purebred beef bulls of average size with exceptional thickness, blockiness, and depth should be used and the so-called easy-keeping characteristic should be present.

Best Season for Calving. The smaller farm herds in the Corn Belt areas are usually fed and sheltered in such a way that early calving can be practiced. This practice is most satisfactory if heavy-weight baby beeves are to be sold during the months of highest prices for such slaughter cattle, namely, late spring, summer, and early fall.

Table 229 shows the advantage of early calving in a Missouri Experiment Station test in which winter calves were compared with spring calves. For these calves to be considered genuine baby beeves they would have had to be fed until the spring months, but the data still show how early calving resulted in faster gains and better utilization of the concentrates fed. Note also that creep-feeding of the nursing calves did not cause the late calves to make up the deficiency in summer gains.

Farther south, where winter small grain pastures are possible, still earlier calving is recommended, with the fed calves being sold in early fall the next year at about 10 months of age.

Development of Home-Bred Calves. Cow-and-calf men who follow the baby-beef plan have the choice of three recognized methods of developing their calves. In the first place the calves may be allowed to run with their mothers without grain until weaning time, when they are weaned, removed to the dry lot, and started on feed. When handled in this way, home-raised calves are at least comparable to western-bred calves as far as their weight, condition, and so forth are concerned.

The second method of handling home-bred calves is to creep-feed them on a good grain mixture from the time they are 3 to 5 weeks old and to continue their feeding throughout the time they are nursing their mothers. This feeding may be done by the use of creeps in the case of calves which are allowed to run with their dams, or the calves may be kept in a separate lot or pasture and fed mornings and evenings before the cows are turned in for the calves to nurse. As a result of this feeding during the suckling period, the calves are considerably heavier and fatter at weaning time than western-bred calves and, consequently, may be marketed after a much shorter feeding period. Usually such animals are in choice slaughter condition at

adapted to the southern fringes of the Corn Belt and the whole of the Southeast, South, and Southwest.

Definition of Baby-Beef and Fat Slaughter Calves. A "baby beef" slaughter animal is generally defined as a beef calf ranging in age from 8 to 15 months, weighing 650 to 950 pounds and carrying enough condition and beef conformation to grade at least low choice, but preferably better, in the carcass. Slaughter "fat calves," on the other hand, are calves which weigh 500 to 750 pounds at ages of 6 to 10 months. These calves generally show considerable bloom and condition, yielding carcasses that grade in the upper end of good grade and better. The beef conformation or "beefiness" of the fat-calf carcass is less pronounced than in the baby beef. Such calves are generally sold directly from the cow—that is, without a post-weaning feeding period.

OPERATION OF THE BABY-BEEF PROGRAM

It is estimated that over half of the feeder cattle fed out in the grain-growing states are of native origin—that is, they are produced in herds not too distant from the feed lots where they are eventually fed out. It is also a fact that a low volume of business is one of the real disadvantages of maintaining a cow herd in these areas. Since grain and harvested roughage of average to good quality are generally produced either on the farm which maintains the cow herd or nearby, it seems only logical that the cow-and-calf man in these areas should feed out his own home-raised calves.

Consumer preference studies show that the cuts from well-finished young animals of good beef breeding are always in strong demand. Animals which yield this kind of carcass are never plentiful but they are especially scarce in summer and early fall, resulting in strong prices for baby beef during these months.

Quality of Animals to Use. Since baby beeves are sold at a relatively young age and yét are beyond the "milk fat" stage, superior beef qualities must be present in the cows and bulls used in this program. Although growth rate is important, early maturity or early finishing characteristics must be present along with beefiness and thickness. Heavy-milking cows are essential because the most profitable baby beeves have made considerable of their total gain while nursing their dams. The extra finish or bloom on the calves at weaning time is not lost, as it is in the typical range cow-calf operation, because the calves immediately go onto at least a partial feed of grain, if not on full feed. Thus only heavy-milking cows of choice

the right kind of early-maturing ancestry and if fed to the limit of their capacity to utilize feed, such calves weigh 600 to 750 pounds at 9 to 11 months of age. Though the beef from such animals lacks the color and flavor usually associated with choice beef, butchers seem to have no trouble disposing of it to the increasing number of customers whose chief considerations when purchasing meat are tenderness and freedom from waste fat.

Each of the three methods of developing calves mentioned above has its advantages and disadvantages. The method that is best suited to a particular farm depends largely upon the type of the individuals composing the cow herd, the feeds available for the cows after freshening, the equipment for taking care of young calves in cold weather, the milking qualities of the cows, and the intended date for marketing the finished calves.

Value of Creep-Feeding. Experiments carried on at Sni-a-Bar Farms, Grain Valley, Missouri, a number of years ago, under the supervision of the United States Department of Agriculture and the University of Missouri, show conclusively that calves fed grain while suckling their dams return much more profit when sold for slaughter at weaning time than those which are not so fed. (See Table 230.) As a result of feeding 3 to 6 pounds of grain daily, or an average of approximately 700 pounds per head, the calves were 100 pounds heavier at weaning time and were valued at approximately $2 more per hundred. Thus, by feeding from $7 to $22 worth of grain per head, depending upon current feed prices and the length of the suckling period, the average value of the calves when weaned was increased from $14.33 to $18.84 per head above the market value of the grain

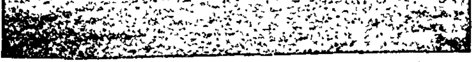

FIG. 88. Home-bred calves of choice or better quality are preferred for the baby-beef program (American Shorthorn Association)

Table 229

Effect of Winter or Spring Calving upon Calf Gains and Feed Requirements*

Calving Season	Jan.-Feb.	Mar.-May
Nursing Period (Creep-Fed)		
No. in each lot	12	14
Av. initial weight, lb.	165 (Mar. 13)	157 (June 5)
Av. weaning weight, lb.	583 (Oct. 3)	507 (Dec. 3)
Av. gain to weaning, lb.	418	350
Av. daily gain, lb.	2.05	1.89
Av. daily ration, lb.		
Shelled corn	2.70	2.79
Cottonseed meal	0.34	0.35
Av. total feed consumed, lb.		
Shelled corn	548 (9.7 bu.)	498 (8.9 bu.)
Cottonseed meal	68.7	62.4
Feed required/cwt. gain, lb.		
Shelled corn	131.7	146.56
Cottonseed meal	16.48	18.35
After-Weaning Period		
Av. final weight, lb.	752 (Dec. 3)	658 (Feb. 12)
Av. gain after weaning, lb.	142	151
Av. daily gain, lb	2.33	2.13
Av. daily ration, lb		
Shelled corn	11.73	12.09
Cottonseed meal	1.55	1.55
Alfalfa hay	3.71	2.36
Av. total feed consumed, lb.		
Shelled corn	715 (12.7 bu.)	859 (15.3 bu.)
Cottonseed meal	91.2	108.1
Alfalfa hay	226	167.7
Feed required/cwt. gain, lb.		
Shelled corn	503	568
Cottonseed meal	67	71
Alfalfa hay	159	111

* Missouri Experiment Station Bulletin 652, 1955.

12 to 15 months of age, when they weigh 800 to 950 pounds. The butcher has this kind of calf in mind when he speaks of the superior quality of "native baby beef."

The third and last method of developing home-bred calves is one representing ultra-baby-beef production. This plan requires that the calves be born early, preferably from September to February, or at least by the middle of March, so that they are sufficiently mature and well finished to be marketed directly off the cows. If backed up with

Table 230

EFFECT OF FEEDING NURSING CALVES UPON RETURN REALIZED WHEN CALVES ARE SOLD AT VARIOUS AGES*

	Not Fed	Creep-fed While Running with Cows	Kept from Cows and Fed Separately	Creep-fed During Last 4-8 Weeks
Sold at weaning time:				
Av. weight (without shrink)	490	593	588	522
Value per cwt.	$9.30	$11.30	$10 90	$9 75
Value per head	$45.60	$67.00	$64.10	$50 90
Amount of grain fed to date.	....	720 lbs.	720 lbs.	180 lbs.
Value of grain fed to date[a]	....	$10 80	$10.80	$2 70
Gross return per head above cost of feed	$45.60	$56 20	$53.30	$48 20
Sold after 84 days of dry-lot feeding:				
Av. weight (without shrink)	665	770	760	695
Value per cwt.	$10.30	$11.70	$11 25	$10 05
Value per head	$68.50	$90 10	$85 50	$69 85
Amount of grain fed to date.	760 lbs.	1760 lbs.	1700 lbs.	1050 lbs.
Amount of hay fed to date.	335 lbs.	265 lbs.	245 lbs.	290 lbs.
Amount of silage fed to date	220 lbs.	135 lbs.	120 lbs.	200 lbs.
Value of feed fed to date[a]	$14.60	$28.80	$27.70	$18.50
Gross return per head above cost of feed	$53.90	$61.30	$57.80	$51.35
Sold after 196 days of dry-lot feeding:				
Av. weight (without shrink)	927	1007	976	947
Value per cwt.	$12 75	$12 95	$12.60	$12.60
Value per head	$118.20	$130 40	$123 00	$119.30
Amount of feed fed to date:				
Grain	2535 lbs.	3610 lbs.	3445 lbs.	2840 lbs.
Hay	720 lbs.	580 lbs.	550 lbs.	655 lbs.
Silage	500 lbs.	365 lbs.	295 lbs.	470 lbs.
Value of feed fed to date[a]	$44.90	$59.60	$56.70	$48 90
Gross return per head above feed cost	$73.30	$70.80	$66.30	$70.40

* U.S.D.A. and Missouri Experiment Station Reports

[a] Feed prices used: Grain—$30 per ton, hay—$15 per ton, silage—$6 per ton.

consumed. These figures apply to the calves which were fed while running with their mothers during the entire summer period. Smaller increases were obtained where the feeding was done during only the 4 to 8 weeks immediately preceding weaning.

Early calves that have been fed grain throughout the summer are sufficiently finished by late fall to be sold for slaughter. Profits from calves so handled have been very satisfactory, judging from the results of the records made in the Kansas Beef Production Contest for 1946–1950. (See Table 231.) When calves can be sold at approximately 11 months of age for $165 to $250 per head after eating from 15 to 25 bushels of grain, there is little incentive for keeping them over the winter months to be sold in May or June on what is likely to prove a less satisfactory market than that which prevailed the previous fall. Whereas it may be argued that the selling of calves at so young an age is economically unsound as far as the meat supply of the nation is concerned, the individual producer can hardly be criticized for disposing of his cattle at such time as they return him the most profit. Mothers of baby-beef calves must be heavy-milking cows that give them a good start and keep them growing at their maximum ability throughout the summer and fall. Indeed, should the cow continue to suckle her calf until it is ready for market, so much the better under this system of baby-beef production.

Although it is highly important to feed grain to calves that are to be sold for slaughter when or soon after they are weaned, grain-feeding during the suckling period does not appear to be especially advantageous if the calves are to be fed throughout the winter and spring and marketed sometime the following summer. Here again, data furnished by the Sni-a-Bar experiments are of considerable value. Table 230 shows that, whereas the calves fed grain during the nursing period were worth about $20 more per head at weaning time than the calves that were not so fed, this difference in value had decreased to only about $10 per head at the end of 196 days of dry-lot feeding. Meanwhile feed costs had mounted much more rapidly, both on the basis of cost per head and cost per hundredweight of gain made, when grain had been fed previously to weaning. When marketed after 6½ months of feeding, the calves that had had only mother's milk during the summer were the more profitable. The practical application of this discussion is simply this: If calves are to be sold at weaning time or after a comparatively short feed in dry lot, grain-feeding during the suckling period is highly essential in producing a satisfactory market finish. However, if the calves are to be marketed as heavier baby beeves in late spring or summer the following year,

tion is fortunate because the area also corresponds very well with the region in which this specialized cow-calf program is best adapted.

Type of Breeding Animals Preferred. *Contrary to the programs* thus far discussed, somewhat less than ideal beef conformation is quite acceptable in the brood cows used in this program. In fact, cows of mixed beef and dairy breeding are preferred because, as a rule, they are better milkers than cows of straight beef breeding, although of course there are variations within each group. Investigators at the Kentucky Experiment Station have studied this program extensively and are among its strongest proponents for mixed farming areas such as those of Kentucky. They have this to say about the type of cow and bull which is most acceptable for this program:

> Select healthy, rugged heifers or cows of fair to poor dairy breeding or of mixed dairy and beef breeding. These cows should be able to produce 2 to 3 gallons of milk daily when newly fresh and to maintain fair milk production for at least 8 to 10 months. The better dairy cows give too much milk for one calf. Most high-grade or purebred beef cows sell too high and don't give enough milk for this plan. Fair quality cattle of the dual-purpose breeds, such as Milking Shorthorns and Red Polls, are well suited to this plan but they are relatively scarce and hence high in price.
>
> *Use larger-than-average purebred beef bulls of the thick, meaty type* Calves by such bulls sell for $15 to $30 more per head at market time. The size of the bull and his ability to sire large, growthy calves having blocky beef conformation are more important than his breed.[1]

Again, contrary to the recommendations in previously discussed cow-calf programs, herd replacements should, in most cases, not be

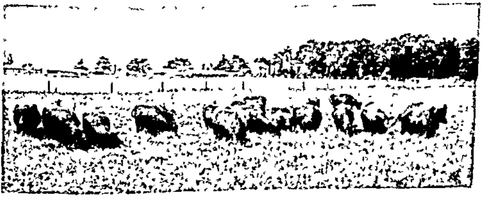

FIG. 89. Well-bred Red Poll cows are exceptionally well suited to the fat-calf program. Calves may be allowed to run with their mothers or, if milk flow is heavy, allowing the calves to nurse twice daily may be preferred (Pinney-Purdue Farm, Wanatah, Indiana)

[1] Kentucky Extension Circular 491

Table 231

RESULTS OBTAINED BY KANSAS FARMERS IN CREEP-FED DIVISION OF BEEF PRODUCTION CONTEST*

	1946	1947	1948	1949	1950	5-Year Average[a]
Number of herds	4	9	12	5	15	9
Number of cows	166	300	503	177	497	329
Per cent calf crop	95	95	92	95 5	98	95
Feed cost per cow	$30 53	$37.64	$43.57	$35.36	$50.55	$39.53
Other costs[b]	$9.90	$7.74	$14 19	$12.26	$17.18	$12.25
Total costs per cow	$40 43	$45.38	$57.76	$47.62	$67.73	$51.78
Age of calves when sold, days	347	310	351	347	334	338
Av. selling weight, lb.	778	710	717	690	760	731
Av. sale price per cwt.	$22 80	$27 65	$25.85	$23.95	$33.15	$26.70
Gross value per calf	$177 38	$196.31	$185.34	$165.25	$251 94	$195.22
Feed fed per calf	$29 80	$53.26	$37.01	$28.99	$48.32	$39.53
Other expenses per calf[c]	$3 12	$2 93	$3.11	$4.69	$6.28	$4 03
Cow cost per calf	$42.56	$47.77	$62.78	$49.86	$67.73	$54.14
Net return per calf	$101 90	$93.35	$82.43	$81.71	$129.61	$97.80

* Computed from Kansas Extension Service, Mimeo Reports, Beef Production Contests, 1946–1950.
[a] All averages are simple averages, not weighted
[b] Bull costs, taxes, and other cash costs, but not labor, interest, depreciation, etc.
[c] Principally marketing costs.

creep-feeding is not to be recommended because the extra flesh so acquired results in slower and costlier gains during the long feeding period.

OPERATION OF THE FAT-CALF PROGRAM

The fat-calf or slaughter-calf program offers the non-range area cow-and-calf man with a herd of cows lacking somewhat in beef breeding the same opportunities for enlarging his business and for better utilizing the home-grown feed supply and pasture as the baby-beef program does for the man with the better bred cows just discussed. Returns come quickly in the fat-calf program since calves are seldom over 8 or 9 months old when sold. There is a ready market for the 275- to 350-pound carcasses yielded by these calves because they are light, tender, and require a minimum of trimming. The consumers in the region below a line extending from Washington, D.C., to Amarillo, Texas, are especially fond of this type of beef. This situa-

tion is fortunate because the area also corresponds very well with the region in which this specialized cow-calf program is best adapted.

Type of Breeding Animals Preferred. Contrary to the programs thus far discussed, somewhat less than ideal beef conformation is quite acceptable in the brood cows used in this program. In fact, cows of mixed beef and dairy breeding are preferred because, as a rule, they are better milkers than cows of straight beef breeding, although of course there are variations within each group. Investigators at the Kentucky Experiment Station have studied this program extensively and are among its strongest proponents for mixed farming areas such as those of Kentucky. They have this to say about the type of cow and bull which is most acceptable for this program:

> Select healthy, rugged heifers or cows of fair to poor dairy breeding or of mixed dairy and beef breeding. These cows should be able to produce 2 to 3 gallons of milk daily when newly fresh and to maintain fair milk production for at least 8 to 10 months. The better dairy cows give too much milk for one calf. Most high-grade or purebred beef cows sell too high and don't give enough milk for this plan. Fair quality cattle of the dual-purpose breeds, such as Milking Shorthorns and Red Polls, are well suited to this plan but they are relatively scarce and hence high in price.
>
> Use larger-than-average purebred beef bulls of the thick, meaty type. Calves by such bulls sell for $15 to $30 more per head at market time. The size of the bull and his ability to sire large, growthy calves having blocky beef conformation are more important than his breed.[1]

Again, contrary to the recommendations in previously discussed cow-calf programs, herd replacements should, in most cases, not be

FIG. 89. Well-bred Red Poll cows are exceptionally well suited to the fat-calf program. Calves may be allowed to run with their mothers or, if milk flow is heavy, allowing the calves to nurse twice daily may be preferred. (Pinney-Purdue Farm, Wanatah, Indiana.)

[1] Kentucky Extension Circular 494

made from among the heifers raised in the herd. Continuing to save the heifer calves sired by the purebred beef bulls as recommended for use in this program tends to increase the beef breeding in the cow herd with each succeeding generation, resulting in lighter calves owing to the reduced milking ability of the cows. An exception to the above rule might be the person who is striving to upgrade a herd so as to have enough quality in the herd eventually to produce high-quality feeder calves or baby beeves.

Herd replacements of the desired breeding can usually be bought in the neighborhood. Buying them at weaning time has several advantages. If bought directly from the breeder, the sire and the dams of the heifer calves can be evaluated, the outlay of cash is lower than for older females, the health of the herd and of the heifers can be observed, and calfhood vaccination for Bang's disease can still be practiced if the calves are not over 8 months of age.

Good data relative to the economics of the two cow-calf programs just discussed are not available, but observations by the author would indicate that most of the smaller cow herds in the South, Southeast, and Southwest are more profitable when the fat-calf plan is followed.

Best Season for Calving. Since fat-slaughter calves are best sold for slaughter at weaning time or "off the teat," the period of highest prices plays a large role in determining the calving date. Figure 90 shows that, in the Southwest at least, the best prices for slaughter

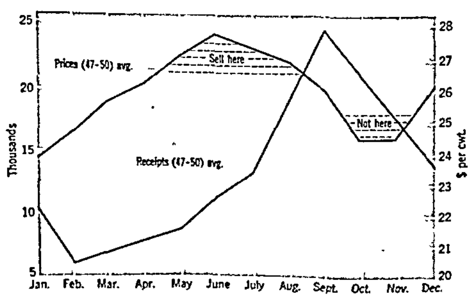

FIG. 90. Effect of season upon receipts and average price received for choice slaughter calves, 1947–1950. (Oklahoma Extension Circular 619.)

calves are received during the months of May, June, and July. Thus for this region the best time for calving would be about 8 months previous to this period, or from September to December. Fortunately the weather is favorable for calving at this time of year in this region, and both cows and calves are quite adequately nourished on the winter oats and wheat pastures grown there.

Local seasonal market demands, winter feed supply, quantity and quality of the labor supply, the weather, and the shelter available, are all involved in the choice of calving season but, generally speaking, fall and winter calvings are more profitable in this program than spring calvings.

Feeding the Nursing Cows. Cows that calve in the fall or winter present nutritional problems which are different from those previously discussed. Economical use must be made of home-grown feeds and pasture or otherwise the cost of meeting the rather high nutrient requirements of the nursing cow soon more than absorb the profits possible with this program. It should be kept in mind that if fall and winter calving is practiced, the cows will be dry in summer when pastures are usually of sufficient quality to produce good gains on such cows. Therefore the feeding program for the nursing cows should be adequate for good milk production, but it need not be high enough in energy content to maintain cow weight as was advocated for the cow-and-calf programs in which cows were dry in winter. Loss of some weight on the part of the nursing cow should be considered normal. A possible exception is the first-calf 2-year-old heifer that might fail to conceive for the next calf unless she is fairly well nourished.

Tables 232 and 233 show that winter pasture, in this case rye-vetch pasture, is a satisfactory, yet cheaper ration for the nursing cow than native grass and supplement, or native grass, silage, and supplement. It is true that the calves nursing the silage-fed cows were somewhat heavier and fatter at weaning and therefore sale time, but the higher cost of the cows' winter ration was not covered by the additional gross return per calf.

The use of winter pasture also reduced the amount of creep ration consumed by the nursing calves by about one-third. The reduced consumption of creep ration by the calves on winter pasture did result in slightly less well finished carcasses but profits were higher in spite of the lower selling price.

The native pasture used in the Oklahoma tests consisted of grass species which do not deteriorate so badly as a result of weathering as do the pastures found in the Southeast and South For this reason the

Table 232

Average Cow Data from Different Feeding Systems in the Production of Fall-Dropped Calves*

Winter Treatment	Lot I Native Grass + Supplement	Lot II Native Grass + Silage and Supplement	Lot III Rye-Vetch Pasture
Number of cows producing calves	18	17	18
Av. cow weights, lb			
Fall, 9/15/54	1,206	1,184	1,156
Spring, 4/19/55	1,053	1,005	1,093
Winter weight loss	−153	−179	−63
Av. daily winter ration (Nov. 1 to Apr. 9), lb. or acres			
Cottonseed meal	2.5	1.5	
Ground ear corn	3.0		
Alfalfa hay†			4.0
Oat hay†			12.0
Silage‡		51	
Rye-vetch pasture			1.5A
Native grass pasture	8A	5A	4A (Summer only)
Yearly feed cost/cow, $			
Winter supplement	23.59	7.56	6.64
Silage		32.64	
Rye-vetch pasture			20.62
Native grass	22.50	17.50	14.00
Total	46.09	57.70	41.26

* Oklahoma Miscellaneous Publication No. MP-48, 1957.

† Fed during a 42-day period in January and February when it was necessary to supplement Lot 3 cows

‡ Silage (from drought-damaged, immature corn) was available from a self-feeding pit silo, every other day. Amount consumed was estimated from silo measurements at 42 lb. silage per cu. ft.

native pasture results in the tests mentioned are not very applicable in these regions. The feeding of supplemental silage or hay would be more justifiable, in fact a necessity, in these regions. In addition, winter pastures are not quite so satisfactory in these sections because the higher rainfall results in muddy pastures which are damaged by heavy grazing. A combination of winter pasture for grazing when weather permits, and silage or hay for supplemental feeding when

rain and cold weather make *grazing inadvisable, seems best.* Tables 55, 56, and 57 give the nutrient requirements for cows that are nursing calves. The area in which the fat slaughter calf program is recommended also happens to be the area in which minerals are generally deficient in the soil (unless corrected by fertilization) and therefore in the plants. *A mineral mixture should be available to both* cows and nursing calves. A typical, adequate mixture would be one consisting of equal parts of salt, limestone, and bonemeal. The bonemeal might be replaced by one-half as much dicalcium phosphate.

Creep-Feeding the Calf in the Fat-Calf Program. Creep-feeding of the calves produced in this program is a highly recommended practice, whereas it is not recommended for the commercial cow and

Table 233

AVERAGE CALF DATA FROM STUDY OF SYSTEMS OF MANAGEMENT*

(All Calves Creep-Fed and Sold for Slaughter)†

Winter Treatment of Dams	Lot I Native Grass + Supplement	Lot II Native Grass + Silage and Supplement	Lot III Rye-Vetch Pasture
No. of calves marketed	18	17	18
Steers	10	9	10
Heifers	8	8	8
Av. birth date, October	20th	9th	11th
Av. calf weights, lb.			
Birth	77	77	69
End of winter phase, 4/19	462	474	440
Final weight, 5/5	551	574	540
Slaughter data:			
Av. yield, per cent‡	57.2	57.7	56.4
Av. carcass grade (U.S.D A. standard)	Choice−	Choice−	Good+
Av. market value/cwt., $§	19 50	19.74	18 63
Total value per calf, $	107.77	113.27	100.65
Creep-feed consumed/calf, lb.	898	856	590
Creep-feed cost per calf, $	21.21	20 22	13.97
Cow feed cost/cow-calf unit, $	46.09	57.70	41.26
Total cow-calf feed cost, $	67.30	77.92	55.23
Net return over feed cost, $	40.47	35.35	45.42

* Oklahoma Miscellaneous Publication *No. MP-48, 1957*

† Based on average of steer and heifer data for each lot

‡ Hot carcass weights shrunk 2½% (minus hide weight). Values based on final Ft. Reno weights.

§ On-foot market value calculated from yield, grade, and current value of carcass, based on Ft Reno weights.

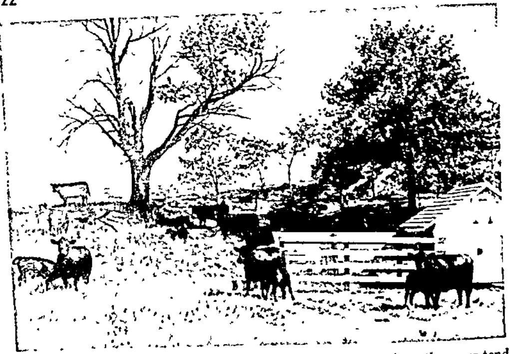

FIG. 91. A creep feeder, ideally located near a shady nook where the cows tend to gather. (American Angus Association.)

calf program mentioned earlier. Creep-feeding is more apt to be profitable if the herd consists of numbers of first-calf heifers or old cows, if drought or mud reduces the forage available as winter pasture, or if the spread between standard- or good- and choice-grading calves is considerable.

Naturally, creep-feeding is successful only if the calves consume the ration offered. The quality of the pasture, location of the creep, and the feeds used in the creep ration all affect the amount of creep-ration consumed. The effect of the quality of the pasture has previously been discussed. The best location for the creep naturally varies from farm to farm, but it should be near the area where the cows spend most of their non-grazing time. This spot might be near a shade, the water supply, or the salt and mineral feeders. On farms where the pasture is adjacent to the farmstead, creep feeders can be located in a part of the barn or shed. In any case the creep feeder should be convenient to the calves, yet protected from damaging rain and other livestock.

The creep ration itself should be (1) extremely palatable, (2) high in energy content, and (3) coarse in nature. Calves prefer either whole grains or coarsely cracked or rolled grains to finely ground feed, and a combination of grains such as corn and oats is generally pre-

Table 234

COMPARISON OF GRAIN RATIONS FOR NURSING BEEF CALVES

Rations Compared	First Series Av. of 3 Years*			Second Series Av. of 2 Years†		
	Shelled Corn	Sh Corn 8 parts C.S.C.‡ 1 part	Sh. Corn 2 parts Oats 1 part	Sh. Corn 8 parts C S.C. 1 part	Gr. Corn 8 parts C.S.C. 1 part	Gr. Corn 8 parts C.S.C. 1 part Gr. Alfalfa-Molasses
Initial age, days	79	81	81	77	81	85
Initial weight, lb.	222	221	220	216	217	217
Final weight, lb.	501	522	496	536	529	524
Total gain, lb.	280	301	277	320	312	307
Daily gain, lb.	2 0	2.15	1.98	2.29	2.23	2.19
Grain eaten per cwt. gain, lb.	177	199	251	187	241	233
Final value per cwt., $	11.65	12.10	11.60	6.80	6.80	6.70
Feed consumed daily, lb.						
1st 28 days	0.5	0.9	1.0	0.7	1.4	1.4
2nd 28 days	1.8	2.8	3.0	1.9	3.7	2.8
3rd 28 days	4.0	4.7	5.4	4.3	5.7	5.1
4th 28 days	5 1	5.9	6.9	6.5	6.9	7.1
5th 28 days	6 3	7.0	8.4	8 0	9.1	9.0
Total, 140 days	3.5	4.3	5.0	4 3	5.4	5.1

* U.S.D.A. *Technical Bulletin 397.*
† U.S.D.A. Technical Bulletin 564
‡ Cottonseed oil cake.

The question of the value of stilbestrol and an antibiotic (terramycin) was tested during the last 47 days of the Oklahoma test already referred to in Tables 232 and 233. Table 235 shows that both the feeding of 5 mg. of stilbestrol daily or a combination of 5 mg. of stilbestrol and 40 mg. of terramycin daily were beneficial. Other research referred to in Chapter 23 indicates that the earlier use of the stilbestrol would have resulted in a still greater increase in weaning weight. Implantation of 24 mg. of stilbestrol could be substituted if desired, without affecting results.

There is no one best combination of feeds in the creep ration. Rather, the supply of home-raised grain available should determine the ration used, with supplemental feeds being held to only the necessary minimum. Ordinarily the home-raised grain should make up at least 90 per cent of the ration. Oats, because of their high fiber content, should not constitute more than half of the ration, at least in the final months before sale.

It may be necessary to make the opening into the creep feeder enclosure wide enough to permit entry of a yearling heifer in order for the nursing calves to learn to use the creep feeder. Penning a few calves in the enclosure during the day or night also is effective in teaching calves to use the creep feeder. The addition of wheat bran to the first feed mixture placed in the feeder is also practiced. Swine, sheep, and chickens should by all means be kept away from the creep feeder.

ferred to a ration consisting of a single grain. The protein concentrate, if included, should be in pellet form so as not to sift out from the rest of the feed mixture. Grain sorghums or barley should always be rolled or coarsely ground, but oats and corn can be fed whole. Including a molasses feed increases feed intake on the part of calves but does not always result in more profit. Table 234 gives results from two tests in which various grain and supplement combinations were tested. Inclusion of a protein concentrate is usually profitable only during the late stages of lactation.

Table 235

EFFECT OF ADDING 5 MG. STILBESTROL OR 5 MG. STILBESTROL + 40 MG. TERRAMYCIN TO CREEP-FEED OF BEEF CALVES*

(Last 47 days on test)

	Basal Creep-Feed	Basal + 5 mg. Stilbestrol per Calf	Basal + 5 mg. Stilbestrol + 40 mg. Terramycin
Number of calves per group†	15	15	15
Av. calf weights, lb.			
Initial, 4/19	470	473	470
Final, 5/5	563	572	578
Av. daily gain	1.97	2.10	2.30
Creep-feed consumed/calf, lb.‡	254	207	229
Creep-feed/cwt. gain, lb.	273	209	212
Slaughter data:§			
Yield, %	57.9	57.7	57.1
Carcass grade	Good+	Good+ to Choice−	Good+ to Choice−
Marbling score	3.47	2.97	3.32
Financial results, $			
Av. cow and calf feed cost‖	67.28	66.36	66.82
Market value/cwt.¶	19.54	19.57	19.23
Total value per calf	110.01	111.92	111.15
Net return/calf	42.73	45.56	44.33
Difference over controls		+2.83	+1.60

* Oklahoma Miscellaneous Publication MP-48, 1957.

† Nine steer calves and six heifers per group, 5 calves in each group from each lot of the original treatment.

‡ Concerns only the amount during this phase.

§ Yield based on hot carcass weight shrunk 2½% (hide off). Marbling score: 1 abundant, 3 moderate, 5 very slight.

‖ Costs prior to this phase based on average for original lots.

¶ Based on current value of carcass according to grade and final weight.

The question of the value of stilbestrol and an antibiotic (terramycin) was tested during the last 47 days of the Oklahoma test already referred to in Tables 232 and 233. Table 235 shows that both the feeding of 5 mg. of stilbestrol daily or a combination of 5 mg. of stilbestrol and 40 mg. of terramycin daily were beneficial. Other research referred to in Chapter 23 indicates that the earlier use of the stilbestrol would have resulted in a still greater increase in weaning weight. Implantation of 24 mg. of stilbestrol could be substituted if desired, without affecting results.

There is no one best combination of feeds in the creep ration. Rather, the supply of home-raised grain available should determine the ration used, with supplemental feeds being held to only the necessary minimum. Ordinarily the home-raised grain should make up at least 90 per cent of the ration. Oats, because of their high fiber content, should not constitute more than half of the ration, at least in the final months before sale.

It may be necessary to make the opening into the creep feeder enclosure wide enough to permit entry of a yearling heifer in order for the nursing calves to learn to use the creep feeder. Penning a few calves in the enclosure during the day or night also is effective in teaching calves to use the creep feeder. The addition of wheat bran to the first feed mixture placed in the feeder is also practiced. Swine, sheep, and chickens should by all means be kept away from the creep feeder.

chapter **25**

THE PUREBRED PROGRAM

The aim of this chapter is not to discuss the pros and cons of the purebred program, but to give information which, it is hoped, will enable a breeder to conduct the program more profitably. Most herds are, after all, operated with the intention of making a profit, contrary to the belief of many who think that most purebred herds are merely a hobby. It is true that a number of wealthy men are purebred breeders, but in most instances such men, like most other breeders, are earnestly and primarily interested in producing the best cattle possible and in making a lasting contribution to the beef cattle industry in particular, and to agriculture in general.

Some of the requirements for success with the purebred program are:

1. Keen business judgment on the part of the owner or manager.
2. Location near, or within ready access of, an area with heavy beef cow population.
3. Skill in choosing herd replacements or in making outside purchases
4. Knowledge of cattle-feeding and herd management.
5. Sufficient capital to make the necessary investments in cattle, land, equipment, and buildings.
6. Sufficient land to produce all of the pasture and roughage, and most of the grain needed.
7. A reputation for honesty.

Successful purebred herds are being operated by men who cannot meet the above requirements in some respects but, generally speaking, if the herd is to be a financial success over a period of years, the above requirements, and possibly others, must be met.

Aims of the Purebred Breeder. Every breeder or would-be breeder of purebred cattle should decide, as nearly as possible, what his ultimate aims as a breeder are likely to be. It is important also to analyze these aims in terms of the means available—that is, capital,

land, climate, and skill or know-how—because these factors determine whether the aims can be achieved. It would be senseless for someone in a remote area of the country—or in an area simply not suited to beef cattle because of, for instance, low soil productivity or extremes in climate—to aspire to reach the top as a cattle breeder. The odds for success would be too great, regardless of how much capital such a prospective breeder might have. This is not to imply that superior cattle could not be produced; what is meant is that the venture would almost certainly be a financial failure.

Purebred breeders and their operations can usually be divided into four rather broad categories. Admittedly there is considerable overlapping and breeders are often in the process of shifting or trying to shift from one category to the next. However, most breeders can be placed in one or the other of these four groups:

1. The so-called "master breeders." Each person's definition of a master breeder is likely to vary somewhat from that of the next Among the important qualifications of the master breeder and his operation is that he must be making a lasting contribution toward improving the cattle of the breed of his choice. The master breeder not only produces superior individuals or show-ring champions; he produces sires or families of females which will leave their influence on the breed for generations to come. He generally stays in business for a long time and often passes the intact herd on to the next generation. Although notable exceptions can be mentioned, master breeders are often men of means, and the beef cattle industry should be thankful that they are. They are usually able to obtain the type of cows or bulls needed in their breeding programs without undue consideration to cost. If a particularly costly individual proves unsuccessful as a producer, financial ruin does not result, as may be the case with the breeder of more limited means Master breeders generally display their cattle at the large shows which, although they may not be a paying proposition, promote the breed and serve as an educational tool for the industry as a whole

Master breeders refuse to be swerved from their aims by the momentary popularity of temporarily fashionable pedigrees or a type of cattle at variance with the real goal of all sound beef cattle breeders The number of master breeders has never been large and is likely never to be.

2. Purebred breeders who furnish the purebred bulls for the commercial cow-and-calf man and the females for many new purebred breeders. Since approximately only 3 per cent of all beef cattle in

the United States are purebred there obviously is room for considerably more. The quality of cattle produced by this type of breeder varies tremendously—from cattle good enough to suit the master breeder, to cattle which should not be multiplied. The better breeders of this group are the backbone of our commercial beef cattle industry because, through the bulls produced in their herds, the quality of our stocker and feeder cattle is determined. The size of the herd and the financial means of such breeders vary greatly and are little associated with the success of the program. One characteristic of this program which is rather consistent is that of location, with the herds usually being located near a market for large numbers of bulls for commercial use. Certainly not all of the calves produced in such herds should be saved as bulls or replacement females. Rather, a good percentage should be sold as stockers or feeders or be fed out on the farms or ranches where they are produced. For herd bulls, breeders in this category often go to the master breeder as a source.

3. Breeders of commercial cattle who keep enough purebreds to produce their own bulls and at least some replacement females. In this group are also those who are slowly but steadily converting their herds from a commercial cow and calf program to a purebred herd. These purebred breeders are often found in the range areas where herds are rather large and numbers of bulls are needed each year. Many young men use this method of growing into the purebred business and, although the process sometimes takes many years, such herds are usually founded on very sound bases because the breeders are aware of the requirements of the commercial operation.

4. Four-H and FFA Projects. Members of 4-H and Future Farmers of America organizations with one to a dozen cows and heifers comprise an extremely important category among the purebred breeders. It would indeed be interesting to know what percentage of the present-day adult breeders got their start in one of these organizations. Knowledge and motivation gained while caring for a 4-H or FFA calf project have started many a breeder in business and, although this method of building a herd is slow, only a small initial investment is required and such herds are often very soundly built. Details concerning this program can always be obtained from the local county agent or from the local vocational agriculture teacher.

Getting a Start with Purebreds. The choice of breed has been discussed in connection with the commercial cow and calf program in Chapter 4 and most of the points made there apply also with respect to the purebred program. Personal preference and adaptation to

climate are the most important considerations in the choice of breed.

Purebred cattle *are generally purchased somewhat differently than* are commercial cattle. First of all, such cattle are usually bought by the head rather than by the pound as commercial cattle are bought. Values of purebred cattle are, of course, determined by supply and demand, as is true of commercial cattle, but there is no real basis for establishing whether the prices asked are reasonable. Predicting the price that may be received for the offspring produced in a purebred program five years hence is all but impossible. It is true that purebred cattle prices swing up and down in sympathy with the commercial cattle market, but many other factors enter the picture. For instance, a drastic shift in demand for purebred cattle of certain bloodlines owing to *an outcropping of such an inherited undesirable trait* as dwarfism can quickly reduce values to the level of commercial cattle prices.

Another difference in method of purchase between purebred and commercial cattle is source. Among the more common sources of purebred cattle are the following:

1. Direct purchase from a breeder by private treaty. This purchase may apply to an entire herd or to a few head, and is the best, although not the most economical, method of buying purebred cattle.
2. Production sale by *larger breeders. The prospective* buyer can obtain much knowledge concerning the performance of the sale cattle by studying the sires, dams, and close relatives of the offerings. It is also possible to observe the conditions under which the cattle were developed if the sale is held at the breeder's farm or ranch.
3. Consignment sale of cattle produced by the members of state, district, or local associations. This is perhaps the least desirable source of purebred cattle, because little information other than pedigree and the individuality of the animals themselves is available. Cattle sold in such sales are often highly fitted due to the competitive aspects of this method of selling. The high condition of such cattle not only serves to cover up weaknesses in conformation but also may impair the fertility and shorten the productive life of many cattle.
4. A father's herd is often the source of 4-H and FFA project heifers and is to be highly recommended if the quality is sufficiently high.

Although the auction method of selling purebred cattle may be a profitable way of merchandising them, it is a questionable method of buying so far as starting a purebred herd is concerned. Sound judg-

ment as to values is often laid aside in the competitive atmosphere of an auction sale. A "bargain" all too often turns out to be someone else's cull, fitted for sale to be bought by an unsuspecting and ill-advised beginner. If a large number of cattle are to be purchased the buyer would do well to seek the advice and help of a highly reliable fellow breeder or breed association field man. A highly trained, experienced herd manager or herdsman is often a real asset at the very outset of the purebred program because of his ability to select and purchase the foundation stock. All too often a new breeder, short on experience but long on enthusiasm and capital, personally buys his foundation cattle from questionable sources and at exorbitant prices. Only after making his initial investment does he feel the need for an experienced manager, but a real handicap has already been placed upon the financial outcome of the program. Such programs are generally doomed to failure from the outset.

The quality of animal to purchase is determined largely by the goals set by the breeder and by the financial means available. The average breeder would do well to pay only moderate prices for his females but in no case should a sire of anything but top quality be used. Taking advantage of all available production-testing information is even more important in the purebred program than in the commercial cow and calf programs. The purebred breeder of the future may well find production-testing an essential part of effective merchandising.

Breeding Season. The purebred breeder has a few additional problems to consider in establishing his breeding season as compared with the commercial breeder. Just as in the commercial program, feed supply, available shelter and labor, and marketing time are important considerations. If a purebred breeder plans to show his animals, or if he wishes to attract buyers who do, he should give consideration to the age classifications which are fairly standard in shows throughout the country. January 1, May 1, and September 1 are the principal base dates upon which such classifications are usually made, and the following classification is representative of those found in open class shows:

Two-year-old—calved between January 1 and August 31, two years previous.

Senior yearling—calved between September 1 and December 31, two years previous.

Junior yearling—calved between January 1 and April 30, previous year.

Summer yearling—calved between May 1 and August 31, previous year.

Senior calf—calved between September 1 and December 31, previous year.

Junior calf—calved after January 1, current year.

In several of the breed-association sponsored shows, a further breakdown of the three main groupings into two each, with additional base dates of March 1, July 1, and November 1, is used. This applies especially in the yearling and calf classes. These classifications are subject to change but the trend has been to lower the maximum ages given above and to offer a wider variety of classes for the younger ages. In any case it is highly desirable to bunch calvings *just as soon* after the various base dates as is practical. Since six base dates are coming into use, this point is of less importance because no calf would be more than 2 months younger than its competitors In practice each breeder must decide for himself what his calving plan is to be Many successful purebred herds follow a calving season which is based entirely on the same factors as a commercial program, and still others, especially if artificial insemination is used, breed cows to calve the year around. Larger calf crops result from year-round breeding, but naturally management of the cow herd is then less clear-cut and feed and labor requirements are greater.

Summer Feeding of the Purebred Herd. Most purebred cows calve in the spring or fall but, as just mentioned, some herds may calve the year around. The summer feeding program is determined by the calving season and is therefore discussed under six headings.

Spring-Calving Cows. Since an ample milk supply for the suckling calf is highly desirable in order to insure maximum development and growth, an adequate supply of nutritious pasture is essential for the cow herd. Stocking rates slightly below those recommended for commercial cows would be in order as a guarantee against the hazards of drought. Some breeders, especially in the non-range areas, separate the calves from the cows during the day in order to hand-feed the calves and to feed the cows a small feeding of grain when they are penned with the calves at night for nursing. First-calf heifers and old cows especially benefit from such treatment. The economy of this practice depends upon method of selling and it is doubtful if it pays unless calves are sold at or soon after weaning. Certainly it is not essential for the proper nourishment of the mature cow herself. It should be mentioned that this practice facilitates both hand mating and breeding by artificial insemination. Creep-feeding of calves that are nursing cows in summer is generally recommended for purebred calves simply as a means of insuring bloom and maximum development. Perhaps such feed should be included under the category of

advertisement expenses because, nutritionally speaking, calves, like their mothers, do not require this added feed. In any case, however, feeding the calf extra grain during the nursing period is more justifiable than feeding the cow. Creep rations were discussed in more detail in Chapter 24.

FALL-CALVING COWS. In few cases is it justifiable to feed grain to dry bred cows on pasture in the summer time. Possible exceptions might be very old or lame cows or cows which are to be sold in an auction sale in the fall or winter. Supplementing the pasture with legume or mixed hay may be advisable, especially if pastures consist entirely of grasses and if drought reduces the total supply of forage. However, cows calving in the fall are actually in a better state of nutrition at calving time, even if pasture is short and of poor quality, than cows that calve in the spring. Therefore problems such as poor milk production and calving difficulties arising from poor nutrition are seldom encountered in fall-calving cows.

REPLACEMENT HEIFERS. Heifers which have definitely been chosen as herd replacements need only good pasture during the summer time, whether they are being bred as yearlings or as two-year-olds. The feeding of extra feed can more easily be done during the wintering period if it is believed necessary to insure maximum development. The summer period is one when economy can be practiced without fear of detracting from the appearance of the herd.

SALE HEIFERS. Heifers that are to be sold in the fall or winter as open yearlings or as bred yearlings or two's are more favorably received if fed some grain or high-energy concentrate while they are on summer pasture. A limited feed, that is, about 1 pound per 100 pounds weight of a bulky concentrate mixture results in gains of approximately 2 pounds per day and a definite improvement in condition. A 30- to 60-day dry-lot feeding period in the fall brings the heifers into sale season with adequate condition and at the same time their breeding value has not been impaired. The use of large amounts of oats in the summer and fall rations of sale heifers is recommended. A protein concentrate at this time is of doubtful value if pasture or hay contains considerable legume. If fall-sale heifers are handled in dry lot during the summer, a ration consisting of at least 50 per cent roughage should be fed and, as mentioned above, oats are desirable for summer feeding. Barley or ground ear corn are also bulky and therefore acceptable, but shelled or ground shelled corn or grain sorghum should be fed sparingly. A low-protein, high-molasses, vitamin- and mineral-fortified concentrate is often used in the fitting rations fed in dry lot to insure an adequate intake of total ration and to protect such dry-lot-fed cattle against vitamin A or mineral deficiencies.

SALE BULLS. Since most bull sales are held in late winter and early spring, grain-feeding of yearling or older bulls on grass the previous summer is less important than it is for heifers. If, however, the breeder wishes to attract buyers who may wish to show the bulls they buy in sales, grain-feeding from calfhood is essential. However, most buyers who are buying bulls to use on commercial cows—and this applies especially to the ranchers in the rougher range areas—would rather have their new bulls in less than show shape. They find that such bulls are more fertile and are more apt to range with the cows when turned out to pasture during breeding season. As is the case with heifers, if grain is fed on pasture, bulky feeds such as oats or ground ear corn are preferred. It is doubtful if it is economical to maintain all sale cattle, and especially bulls, in high condition at all times with the hope that the occasional visitor will make a purchase. Rather, the feeding program should usually be so designed that most of the sale cattle are in attractive sale condition only when seasonal demand is high.

THE HERD BULL. With a few possible exceptions, the herd bull needs no additional feed if he is running with the cow herd on good summer pasture. When yearling bulls are used in the non-range areas, the daily feeding of 6 to 10 pounds of oats, ground ear corn, or similar bulky concentrate is often practiced in order to promote growth and development. The same system of supplemental feeding may serve to prolong by several years the useful life of old bulls which may fail to graze sufficiently to maintain their condition.

During the summer time, strict attention should be given to the water, salt, mineral, and shade needs of purebred cattle. Often because some grain is fed, minerals are overlooked.

Winter Feeding of the Purebred Herd. The problem of winter feeding will also be discussed on the basis of the nutritive requirements of the various age and sex groupings which are made. The cow herd itself in many instances consists of both wet and dry cows. Dry cows can be wintered very economically in the same manner as commercial dry cows—that is, on a full feed of legume hay or, better still, mixed hay, or silages made from the same crops. A partial feed of corn or sorghum silage, cereal straw free-choice, and a pound of protein concentrate per day is used extensively in the non-range areas. If cured range grass is used, supplementation with 2 pounds of a vitamin- and mineral-fortified protein concentrate results in good calf production but some loss in weight on the part of the cows. Although this loss may detract from the appearance of the cows somewhat, investment in winter feed can be kept low.

Open yearling or bred yearling and two-year-old replacement heifers

advertisement expenses because, nutritionally speaking, calves, like their mothers, do not require this added feed. In any case, however, feeding the calf extra grain during the nursing period is more justifiable than feeding the cow. Creep rations were discussed in more detail in Chapter 24.

Fall-Calving Cows. In few cases is it justifiable to feed grain to dry bred cows on pasture in the summer time. Possible exceptions might be very old or lame cows or cows which are to be sold in an auction sale in the fall or winter. Supplementing the pasture with legume or mixed hay may be advisable, especially if pastures consist entirely of grasses and if drought reduces the total supply of forage. However, cows calving in the fall are actually in a better state of nutrition at calving time, even if pasture is short and of poor quality, than cows that calve in the spring. Therefore problems such as poor milk production and calving difficulties arising from poor nutrition are seldom encountered in fall-calving cows.

Replacement Heifers. Heifers which have definitely been chosen as herd replacements need only good pasture during the summer time, whether they are being bred as yearlings or as two-year-olds. The feeding of extra feed can more easily be done during the wintering period if it is believed necessary to insure maximum development. The summer period is one when economy can be practiced without fear of detracting from the appearance of the herd.

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Open yearling or bred yearling and two-year-old replacement heifers

attain larger mature size if 2 to 4 pounds of a farm grain or high-energy concentrate is fed with the better roughages during the winter. Again, however, the added condition and size of the heifers adds to the annual feed cost, and it is doubtful if the increased cost can be recovered in terms of larger or heavier calf crops.

Weanling heifer and bull calves should definitely be fed for at least normal growth during winter time with possibly some improvement in condition, especially if the calves have not been sorted into sale and replacement groups. A full feed of good mixed hay or silage plus 4 to 6 pounds of almost any grain mixture is adequate. If prairie hay or other non-legume hay or corn or sorghum silage is used, additional protein is needed. One pound per head of any of the oil seed meals is recommended.

Winter feeding and management of the herd bull were previously discussed in Chapter 10. If annual production sales are held during the winter, additional condition is often desired in herd bulls simply for display purposes. Although this practice cannot be advocated from a health standpoint, there can be no doubt that prospective buyers like to see the sires of sale animals carrying considerable flesh.

Sale Cattle. Winter rations or, for that matter, any ration that is going to be fed to full-fed sale cattle should meet the nutrient requirements for feeder cattle on finishing rations, as set forth in Chapter 15. However, the purebred industry as a whole would be benefited if sale cattle were sold without fitting—that is, without being fed to high condition. As the added cost of the unnecessary fitting ration must be borne by someone, it either cuts into the profits of the original breeder or increases the initial costs to the new breeder. What is probably even more important is that, unless highly fitted animals are "let down" slowly, such animals may well have their productivity interfered with and may even spend the rest of their lives in rough, patchy condition. Founder and cattle fed off their feet and legs are all too common in purebred herds. Naturally such cattle can be salvaged for only commercial prices.

Many special fitting rations are used in purebred herds. More frequent feedings, special methods of preparation such as steam-rolling of grain to insure a bulkier, dust-free ration, cooking the grain portion of the ration, using molasses and dried beet pulp as appetite stimulators, and still many other special adaptations are used by experienced herdsmen in order to increase consumption of ration and to maintain appetites over a long feeding period. The economy of such special treatment depends upon the added price received for sale cattle. Undoubtedly the larger breeders who wish to attract buyers from among

other purebred breeders are of necessity going to continue the practice, but the breeder who sells only to the commercial breeder can keep his investment in feed and extra labor much lower by maintaining his cattle with less condition.

Nurse Cows. Nurse cows or foster mothers are used by many fitters of sale and show cattle. Certainly this practice can be recommended in the case of calves whose dams are poor milkers owing to old age or other similar causes. Otherwise, in principle at least, the practice should be discouraged because all too often inherently poor milk production on the part of the dam of a calf is obscured, whereas it would be better to recognize this fault for what it is and to cull such cows and their offspring from the herd. Furthermore the development of calves on nurse cows is so rapid that many develop unsoundness in the feet and legs. Of course it is difficult to argue with the breeder who knows that he may be able to increase the sale value of an outstanding calf many times simply by fitting the calf to the very *n*th degree. As to the cost of maintaining a nurse cow, it may safely be said that three additional mother beef cows can be fed on the feed consumed annually by a nurse cow. Nurse cows must be fed a concentrate mixture containing 15 to 20 per cent protein at the rate of 10 to 20 pounds daily depending upon the amount of milk produced and upon the size of the cow. Incidentally, Holstein, Brown Swiss, or other cows that produce similar quantities of low fat-testing milk are preferred to such high-testing breeds as the Jersey

Many methods are used to change a calf over from its own mother to a nurse cow. This procedure is often difficult since, in most cases, calves will not be switched over until they are at least 4 months old or older. Probably the most important point in making the change successfully is to make sure that the calf is hungry. This point may necessitate withholding all feed and water from the calf for as long as 48 hours, although considerably less time is usually required. It often helps to permit the calf to nurse its own mother partially, if possible, just before switching it over to its foster mother. Often a nurse cow needs to be hobbled or otherwise restrained to prevent her from kicking or butting the calf. Leading calves to the restrained cow in a nursing barn or stanchion is a recommended practice because it promotes regularity in the feeding schedule and helps in breaking calves to lead.

Dried milk concentrates or reconstituted dried milk show promise of replacing the nurse cow. Further research is needed, but with the use of antibiotics the scours often prevalent when milk substitutes are used can all but be eliminated.

Letting Down Fitted Cattle. Highly fitted cattle that are being retired from a show herd or that may have been purchased at a sale need special attention when they are to be let down in condition. Simply turning such cattle out to pasture or placing them on an all-roughage ration is not recommended. Rather, a gradual reduction in concentrate allowance should be practiced. Raising the fiber content of the grain ration by increasing the oat content is also often practiced. In any case, the feeding of some grain is recommended for up to 3 months while the animal is gradually losing its burden of excess fat. Much exercise such as that obtained by penning the cattle on pasture at all times also assists in letting fitted cattle down.

Care of Feet. As a rule, the feet of cattle being fitted for show or sale require some attention. Animals with long toes or unevenly worn hoofs are less pleasing in appearance and walk less satisfactorily than those that have had their feet shaped up and their toes properly trimmed. The feet can best be worked on while the animal is in a set of stocks such as the one shown in Chapter 27. The sills of the stocks are built at a height that permits the tying of the shank and pastern of the leg in a horizontal position, thus exposing the underside of the foot for trimming. Young cattle can be thrown for foot trimming quite satisfactorily.

The practice of shortening the toes by standing the animal on a hard floor and cutting them off from above with a hammer and chisel is

FIG. 92. Excess hoof growth should be trimmed from the underneath side. A sharp wood chisel is an effective trimming tool if feet are soft from standing in wet lots or pastures. (American Angus Association.)

strongly condemned. Whereas this method may prevent for a time the overlapping or rubbing of toes, it leaves the bearing surface of the foot unchanged, so that the trouble speedily returns. Ill-shapen feet throw an undue strain upon the bones and ligaments of the lower leg. If feet are allowed to go untrimmed, broken-down pasterns result.

Feet that are badly in need of trimming should not be leveled up all at once, but should be trimmed in two or three installments at intervals of a week or 10 days. In this way the foot can be observed to see what effect the last trimming has had and to determine what additional work is necessary. It also does away with the likelihood of cutting away so much horn at one operation as to make the foot tender or to cause bleeding.

Fitting Cattle for Show or Sale. Such subjects as selection of prospective show cattle, grooming, washing, exercising, breaking to lead, care of horns, clipping of heads and tails, and selection of equipment for fitting and showing have been discussed in detail in previous editions of this book. To do justice to these subjects would require much more space than can be allotted to them at the present writing. Furthermore, excellent publications pertaining to these subjects can be obtained for the asking from the various breed associations, whose addresses are listed in the appendix, and from the extension livestock specialists in each state. Generally speaking, problems encountered in developing, fitting, and showing beef cattle are quite specific in nature. It is likely that consultation with an experienced herdsman, fieldman, extension service representative, or vocational agriculture teacher is the quickest and best solution to individual problems.

The Financial Aspect of Purebred Cattle. The breeder of purebreds has financial problems quite different from those of the man who handles only commercial cattle. In the first place the size of his investment in animals is largely a matter of his own choosing, with "the sky as the limit." This is true even though he maintains only an average-sized herd, for what he lacks in numbers can easily be made up in quality and breeding if he is willing to pay the price.

Purebred cattle values vary greatly from herd to herd since there are wide differences in individual merit and in the popularity of the blood lines represented. They also vary greatly from one period to another, largely because of the degree of prosperity enjoyed by the men handling market cattle. When prices of commercial cattle are high there is a strong demand for purebred bulls to produce steers and heifers for the market. This demand results in increased prices for purebred cattle. The close correlation usually existing between fat steer prices and prices for purebred cattle may be seen in Figure 93.

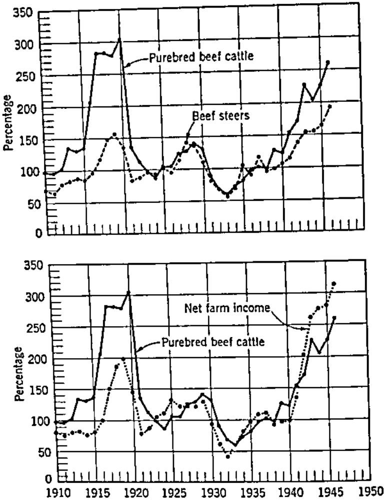

FIG. 93. The relationship of prices of purebred beef cattle to: (*a*) prices of beef steers at Chicago, (*b*) net income of farm operators of the United States. Index number 1935–1939 = 100. (University of Minnesota.)

During the 21-year period 1900–1920, purebred prices, as determined from the published reports of all important public sales of Shorthorn, Hereford, and Angus cattle, averaged approximately 3¼ times the average value per head of native beef steers on the Chicago markets.[1] During the early years of this period, some purebred sales were held at which scarcely better than beef prices were realized. Later on, however, there were literally scores of sales with averages around \$500, whereas the offerings from the more noted herds averaged \$1,000 and upwards

As will be seen from Figure 93, purebred cattle prices skyrocketed during World War I but declined immediately after the war to about

[1] Armour's Livestock Bureau.

the same level they had occupied before 1914 A similar rise in prices occurred during World War II, but instead of receding after the war they continued to climb higher and higher, with each of the three major breeds registering each year from 1947 to 1950 successively higher prices than had been reported previously. Sales of both bulls and females in five figures were common during this period, and averages from $1,000 to $3,000 were realized in scores of public auction sales of purebred cattle.

Despite the record prices paid for outstanding animals representing the most popular lines of breeding, the rank and file of purebred cattle continued to sell at conservative prices In fact, they advanced little more over pre-World War II prices than other agricultural commodities. (See Figure 93.)

Importance of Depreciation Charge in Purebred Herds. The relatively large amount of money invested in purebred cattle exerts a considerable influence upon the financial situation. Interest and depreciation charges and death risks, particularly, are affected. Depreciation is an item that may be almost disregarded in the financial aspect of a herd of grade cows, since the cows are usually sold before age affects their market value. In a herd of purebreds, however, depreciation is of considerable importance since animals bought at high prices are eventually sold for beef. Occasionally the loss suffered from the depreciation on a single animal is sufficiently large to wipe out the profits accruing from the rest of the herd for a full year. Losses from depreciation are particularly heavy during periods of financial depression when prices are falling rapidly These, however, are to a certain extent covered by the appreciation or increase in values enjoyed during

Table 236

PRICES PAID FOR PUREBRED HEREFORD CATTLE AT PUBLIC AUCTION SALES*

	1950	1940	1930	1920
Number of auction sales	573	220	60	283
Number of cattle sold	38,744	17,893	3,732	15,432
Average price	$604	$195	$217	$416
Average of top sale	$5,160	$1,023	$1,068	$4,050
Top price for bull	$70,500	$7,900	$2,500	$22,000
Top price for female	$17,300	$5,350	$7,600	$8,000
Bulls sold for $10,000 or more	46	33†	5†	3
Cows sold for $5,000 or more	31	6†	3†	13

* Compiled from *The American Hereford Journal.*

† Number sold for $2,000 or more.

periods of prosperity when prices are advancing. Unfortunately, comparatively few breeders have many cattle on hand when prices are rising, whereas barns and pastures are likely to be full when values are falling. Moreover, there is a pronounced tendency for new men to enter the purebred business after prices have reached a high level and a majority of them have nothing to sell until the arrival of a period of depression which inevitably follows inflation and overexpansion. The losses suffered on herds so founded are sometimes very large, occasionally necessitating the sale of the cattle for only a fraction of their initial cost. A tax expert should be consulted by breeders of very valuable animals in order to choose the best plan to follow in computing taxable income and deductions.

Operating Costs in Purebred Herds. Operating expenses per animal are somewhat larger for purebred than for grade cattle. The breeder of purebreds, if he is to make progress and succeed, must keep his herd in fairly good condition to insure the maximum development of the young stock and to make a favorable impression on prospective purchasers. This means a larger outlay for feed and labor. Further calls for additional labor result from the general practice of hand mating, from the necessity of keeping the bull and heifer calves separated, from the need for more or less individual feeding and care in order to give each animal the best possible chance to develop, and from the desire of most breeders of purebred cattle to keep the barns and farmstead sufficiently neat and clean to bear inspection by visitors at any time.

As a rule the building and equipment charge per animal is considerably higher in purebred herds than in grade. Although a certain amount of extra equipment beyond that needed for ordinary cattle is highly desirable, elaborate barns and costly equipment are by no means essential to the raising of animals good enough to meet any requirement. A sufficient number of fairly large, roomy box stalls and well-drained paddocks to permit the proper separation of animals on the basis of age and sex constitutes the principal item of equipment needed for the proper handling of a herd of purebred beef cattle.

Cost of Selling Purebred Cattle. The marketing or selling cost of purebred cattle is materially higher than that of grades. Because there is no established market for breeding cattle, each breeder is forced to find his own market, which he proceeds to do through various kinds of advertising. Newspapers, livestock journals, billboards, and letterheads announce to the reading public that he has stock for sale; reproduced photographs, show herds, and public displays of prize ribbons and trophies attest the excellence of his herd as a whole. Even a

certain percentage of the cost of an imposing barn, the expense of painting the paddock fences, and the cost of keeping the breeding animals in somewhat higher condition than that necessary to insure their maximum usefulness should properly be charged to advertising. Returns on money thus expended come from a more ready sale or higher prices for surplus stock rather than from lower operating costs.

The beginning breeder should exercise care lest his selling costs be out of proportion to the prices received. To consign a $300 animal to a sale the expenses of which, including advertising, catalogs, auctioneer, stall rent, freight, expenses of attendant, et cetera, are $50 or more per head, is obviously poor policy. It is likely that the net return would be greater if the sale were made at home at little more than beef prices. Unless one is willing to consider a part of the expense of present-day sales as legitimate advertising for future offerings, the total cost of selling should not exceed 8 to 10 per cent of the expected sale price

Receipts from Purebred Cattle. Receipts from a herd of purebred beef cattle are very irregular in both amount and season During periods of prosperity every surplus animal is taken by eager buyers who show little tendency to haggle over prices. During less favorable times even the more noted breeders have to resort to peddling tactics in order to make sufficient sales to keep their herds down to the required size. At such times it is not unusual for a large percentage of bull calves to be castrated, finished, and sent to market along with the plainer heifers and those cows that have shown only mediocre breeding ability. Although such sales are trying to the individual breeder, they may be of considerable benefit to the breed as a whole, inasmuch as they cause the elimination of the poorer animals from the lists of registered stock.

Price fluctuations have been the downfall of a great many cattle speculators who attempted to get into the purebred business by buying a "ready-made" herd at peak values. However, for the man who builds his own herd from the progeny of a few carefully selected cows of proved merit, price fluctuations, although by no means welcome, are not likely to prove disastrous.

chapter **26**

THE PREPARATION OF FEEDS AND METHODS OF FEEDING

Probably no question connected with the feeding of beef cattle gives the inexperienced feeder more serious concern than that of the choice of method of feed preparation. It is small wonder that he is confused, for every medium of communication is used to extoll the virtues of every conceivable type of feed grinder, crusher, shredder, cooker, and so forth. Since many of the claims made by the manufacturers are in direct contradiction with one another, obviously all cannot be correct. It must be kept in mind that a recommendation or testimonial letter given by a feeder who has tested only one type of machine can be very misleading, because it is quite likely that he has not made comparisons with other machines under controlled conditions, or he may simply have used a new method of processing and liked it in comparison with no processing at all. Furthermore, the importance of convenience all too often is given more emphasis than it deserves, and the economics of a processing method is sometimes almost entirely overlooked.

Fortunately, under normal conditions the particular form in which the feeding stuffs are fed to ruminants in general and cattle in particular, is of minor importance so far as performance of the cattle is concerned. Generally speaking, feeds should be fed in the form that involves the least total labor. Since labor cost comprises more and more of the total cost of finishing a steer with each passing year because of constantly increasing wage rates, building a feed-handling system around the essential processing unit is justifiable.

Preparation of Corn. The topic of corn preparation will receive more attention than the preparation of other feeds for two reasons: first, corn is the most important feed fed to beef cattle that needs preparation in some form, and, second, more experimental work has been done with this feed.

Corn is fed to beef cattle in the following well recognized forms:

1. Standing in the field.
2. Snapped corn.

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1. Standing in the field.
2. Snapped corn.

Snapped Corn. The term "snapped corn" is applied to corn that has been gathered, generally by hand, with the husks remaining on the ears. These husks are of fine texture and are of considerable value as a roughage material. They also tend to preserve the freshness of the ears and prevent the grain and cobs from becoming dry and hard. Snapped corn is, therefore, somewhat more palatable than ordinary ear corn and is consumed, as a rule, in somewhat greater quantities However, a greater wastage of feed occurs since the cattle tend to pick the ears up by the husks and drop some beyond the edges of the troughs before getting them firmly between their jaws. Such ears are, to a large extent, recovered by the swine that follow the cattle

With the exceptions noted above, snapped corn is comparable to ear corn in feeding value. In practice, snapped corn is fed mainly during the fall and early winter months when it can be fed directly from the field. The only region in which this type of corn is fed to any extent is in the South and Southeast where corn acreage on individual farms is too small to justify a mechanical corn picker Coarsely grinding the whole ear, husks and all, with a hammermill renders snapped corn a very satisfactory cattle feed and overcomes the problem of waste referred to above.

Ear Corn. During the first two decades of the twentieth century, when the feeding of 2- and 3-year-old steers was a common practice, large amounts of whole and broken ear corn were fed to beef cattle. For small droves numbering less than 50 head the ears were usually broken by hand into two to four pieces over the edge of the feed trough, but for large droves they were broken into smaller pieces by means of a power-driven mechanical breaker or slicer. Often yearling cattle and calves would be brought up to a full feed on ear corn chopped into pieces about an inch long with an ordinary hand corn-knife. The present scarcity of labor and the availability of tractor and electric power for grinding on nearly every farm have resulted in the almost complete disappearance of broken ear corn from beef cattle feed bunks Nevertheless, it is an unusually good form of corn for starting cattle on feed, especially in the fall and early winter, when the corn often contains too much moisture to be easily ground or to be stored in the form of ground ear corn for more than 2 or 3 days without spoiling

Ear corn is more satisfactory for feeding during the fall and winter while the cobs are soft and spongy. In the spring, with the arrival of warm weather, much of the moisture in the cobs evaporates, rendering the ears more difficult to masticate. For this reason ground ears and shelled corn are more satisfactory for summer feeding

The feeding of ear corn, either whole or broken, is not at all suited to systems of feeding which make use of self-feeders. Furthermore,

3. Ear-corn silage.
4. Broken ears.
5. Chopped green corn.
6. Corn-and-cob meal.
7. Shelled corn.
8. Ground shelled corn.
9. Shelled corn silage.

"Cattling Down" Corn. The use of cattle to harvest corn from the standing stalks is seldom practiced nowadays. In the few instances in which this method of feeding is being followed, the wastage of corn is very high. In eating the corn the cattle knock many of the ears to the ground and show little inclination to eat these ears as long as they can get a full supply from the standing stalks. The fallen ears become dirty and unpalatable with the first rain and must be salvaged by swine. In a test conducted at the Illinois station, 10.5 acres of standing "soft" corn furnished a full feed for ten 2-year-old steers for only 58 days, in comparison with 80 days for an equal acreage fed as shock corn to similar steers in dry lot. The combined cattle and swine gains per acre for the two areas were 175 and 240 pounds, respectively. Although little corn is fed as shock corn, the comparison still points up the wastefulness of this method of feeding.

One of the problems of running feeder cattle in a field of standing corn is the difficulty of supplying the protein required to balance the ration Since the cattle consume considerable roughage in the form of husks and cobs, they eat relatively little legume hay. The feeding of a protein concentrate presents the problem of insuring that each steer gets his share of the small amount fed. This may be done by mixing the protein supplement with about its own weight of chaffed hay in order to prevent the more aggressive steers from consuming all of it before the more timid animals reach the feed trough.

Cattling down corn should be attempted only with cattle accustomed to a full feed. A sufficient number of swine should be put into the field to utilize both the corn that the cattle knock to the ground and the undigested corn voided by the cattle in their feces. Three times as many swine are needed with a drove of cattle running in a corn field as are needed in a dry lot From two to four 80- to 120-pound shoats per steer are usually required.

Shock corn, the most common form in which corn was fed in the early days of cattle feeding, can no longer be recommended. The corn picker and the corn combine, together with the need for destroying the corn-borer larvae harbored in most corn stalks, today make the feeding of shocked corn obsolete.

Snapped Corn. The term "snapped corn" is applied to corn that has been gathered, generally by hand, with the husks remaining on the ears. These husks are of fine texture and are of considerable value as a roughage material. They also tend to preserve the freshness of the ears and prevent the grain and cobs from becoming dry and hard. Snapped corn is, therefore, somewhat more palatable than ordinary ear corn and is consumed, as a rule, in somewhat greater quantities. However, a greater wastage of feed occurs since the cattle tend to pick the ears up by the husks and drop some beyond the edges of the troughs before getting them firmly between their jaws. Such ears are, to a large extent, recovered by the swine that follow the cattle.

With the exceptions noted above, snapped corn is comparable to ear corn in feeding value. In practice, snapped corn is fed mainly during the fall and early winter months when it can be fed directly from the field. The only region in which this type of corn is fed to any extent is in the South and Southeast where corn acreage on individual farms is too small to justify a mechanical corn picker. Coarsely grinding the whole ear, husks and all, with a hammermill renders snapped corn a very satisfactory cattle feed and overcomes the problem of waste referred to above.

Ear Corn. During the first two decades of the twentieth century, when the feeding of 2- and 3-year-old steers was a common practice, large amounts of whole and broken ear corn were fed to beef cattle. For small droves numbering less than 50 head the ears were usually broken by hand into two to four pieces over the edge of the feed trough, but for large droves they were broken into smaller pieces by means of a power-driven mechanical breaker or slicer. Often yearling cattle and calves would be brought up to a full feed on ear corn chopped into pieces about an inch long with an ordinary hand corn-knife. The present scarcity of labor and the availability of tractor and electric power for grinding on nearly every farm have resulted in the almost complete disappearance of broken ear corn from beef cattle feed bunks. Nevertheless, it is an unusually good form of corn for starting cattle on feed, especially in the fall and early winter, when the corn often contains too much moisture to be easily ground or to be stored in the form of ground ear corn for more than 2 or 3 days without spoiling.

Ear corn is more satisfactory for feeding during the fall and winter while the cobs are soft and spongy. In the spring, with the arrival of warm weather, much of the moisture in the cobs evaporates, rendering the ears more difficult to masticate. For this reason ground ears and shelled corn are more satisfactory for summer feeding.

The feeding of ear corn, either whole or broken, is not at all suited to systems of feeding which make use of self-feeders. Furthermore,

the newer, automatically controlled feed handling systems will not handle such corn.

The feeding of ear-corn silage has been discussed in Chapter 16. However, in connection with preparation of corn it should be mentioned that this method of harvesting, storing, and feeding corn to feeder cattle has several points in its favor, not the least of which is the possibility of saving labor when the feeding operation is mechanized. The only question of real concern is that of the economy of grinding and storing the cob portion of the ear, especially if the more expensive, glass-lined, oxygen-free silos are used. It should be remembered, however, that the cob portion of the ear may have a feeding value of as high as three-fourths that of the grain on a pound for pound basis. Since the cob portion of ear-corn silage is readily consumed, if not too coarsely ground, this also overcomes one of the problems with ground ear corn. Since the cob makes up approximately 20 per cent of the weight of ear corn, it goes a long way toward meeting the roughage requirement of feeder cattle. This should be kept in mind when deciding how much additional roughage to feed to cattle which are on a full feed of corn. Ordinarily only half as much hay or silage is required when ear-corn silage is fed as when shelled or ground shelled corn is fed.

Shelled Corn. Shelled corn is obviously a more concentrated feed than ear corn since the cobs are not present. Corn cobs, because of their high fiber content, have a lower net energy value. In this respect they are comparable to the roughage component of the ration, and their presence usually permits some saving in this item, as mentioned above.

Given a fairly liberal roughage ration, cattle make more rapid gains on shelled than on ear corn. This gain is principally due to the fact that a larger weight of corn kernels is consumed. Consumption is larger because shelled corn is more palatable and because passage from the digestive tract is faster. It may appear from the results of some feeding experiments that shelled corn is more thoroughly digested, since the swine gains per bushel of corn fed were larger with ear corn. However, some of this pork probably was due to ears that were "nosed" from the trough or were dropped to the ground and, therefore, were not consumed by the cattle.

The superiority of shelled corn over ear corn is never great but is more pronounced during the summer and fall, when the ears are likely to be hard and dry and difficult to masticate. The claim is often made that shelled corn has a decided advantage for cattle getting silage or for cattle on grass, because the succulent feeds tend to make their mouths tender, rendering them less able to masticate ear corn. A more

plausible explanation is that cattle fed silage or running on grass tend to consume large quantities of these palatable roughages and have too little capacity for a bulky feed like ear corn to eat enough of it to make large gains.

Ear corn in all forms is a somewhat safer feed than shelled corn since cattle getting it are not so likely to overeat and go off feed. Many practical feeders prefer ear corn for this reason. It is often used for the first 5 or 6 weeks while the cattle are learning to eat. A change is then made to shelled corn as soon as all the cattle are eating well and are on nearly a full feed.

Ground Corn. The term "ground corn" may be used to refer either to the ground ears or ground shelled corn. Strictly speaking, ground ears go by the name "crushed ear corn" or "corn-and-cob meal," according to whether the ears are ground coarse or fine, and ground shelled corn is called merely "ground corn" or "corn meal" if the grinding has been especially thorough. As a rule, crushed ear corn is the form more commonly used by feeders who are preparing cattle for the open market, whereas coarsely ground shelled corn is extensively used in fitting cattle for the showyard or sale ring, or in feeding with silage.

The grinding of corn, either ear or shelled, is done primarily to promote faster daily gains. This increase in gain results partly from a larger consumption of grain and partly from a better utilization of the grain by the cattle. More ground than whole grain is eaten, for reasons unknown. The breaking up of the kernels into many minute particles probably makes the corn more palatable or "tasty." The finer the corn is ground, the greater the surface that is exposed to the action of the bacterial flora of the paunch and the digestive juices, which easily penetrate each small piece of the ground grains, transforming their proteins and starches into simpler products that are easily absorbed. On the other hand, an appreciable percentage of corn that is fed whole passes through the entire digestive tract without having even its outer covering broken. In addition, there are other kernels that have been only partly chewed and are imperfectly digested. Grinding aids the process of digestion, as indicated both by the smaller amount of ground than of whole corn required per pound of gain and by the smaller gains made by swine which are in the lot with cattle fed ground corn. However, the results of the Nebraska and Iowa experiments reported in Table 237 indicate that coarsely cracked shelled corn is utilized little better, if at all better, than shelled corn by yearling cattle. The difference observed in swine gains in these experiments, as in most comparisons between whole and ground corn, must therefore be attributed principally to the inability of the swine

Table 237

THE VALUE OF GRINDING SHELLED CORN FOR YEARLING STEERS

	Nebraska Experiment Station*				Iowa Experiment Station†	
	First Trial		Second Trial			
	Shelled Corn	Coarsely Ground Shelled Corn	Shelled Corn	Coarsely Ground Shelled Corn	Shelled Corn	Coarsely Ground Shelled Corn
Initial weight, lb	638	642	671	670	657	656
Final weight, lb.	1,067	1,075	1,063	1,076	1,121	1,105
Average daily gain	2.38	2.40	2.17	2.26	1.94	1.87
Average daily ration						
Corn (shelled basis)	16.5	17.8	14.9	15.2	12.1	11.2
Corn (cobs)	...	...	...	...	...	...
Alfalfa hay	5.3	5.9	5.4	5.3	1.5	1.5
Corn silage	...	...	...	...	11.5	11.5
Feed per cwt gain						
Corn (shelled)	692	742	686	673	625	600
Corn (cobs)	...	.	...	...	...	...
Alfalfa hay	222	247	250	235	79	82
Corn silage	...	...	...	...	593	612
Hog gains per steer	29	15	51	25	57‡	18‡
Dressing percentage	60 4	61.2	59 7	59.5	...	...

* Nebraska Mimeographed Cattle Circular 143.
† Iowa Animal Husbandry Mimeographed Leaflet 159.
‡ Feed saved by hogs per 100 pounds of cattle gains.

to recover the small particles of undigested grain voided by the steers fed ground corn.

Corn-and-cob meal has almost the same relation to ground corn that broken ears have to the shelled grain. The cob particles that are in the former result in a slightly smaller daily grain consumption than may be secured from feeding the latter. In the absence of sufficient roughage, these cob particles may be of considerable benefit in lightening the ration and giving it bulk. The presence of the cob particles also makes corn-and-cob meal a somewhat safer feed than ground shelled corn because cattle getting it are not as likely to overeat and go off feed.

Great variation exists in the degree of fineness attained in grinding corn. In some cases the ears are merely crushed, leaving many of the grains unbroken and particles of cob one-half inch or more in length. In others, the grinding is so thorough that the ground cobs have much the appearance of coarse middlings or bran. Shelled corn may be merely cracked or it may be reduced to a genuine meal.

As a rule, coarsely ground shelled corn is preferred to finely ground. When reduced to the consistency of a fine meal it tends, when eaten,

to make a sticky, pasty mass which is believed by many to be more or less unpalatable to full-fed cattle. Ear corn, on the other hand, should be ground rather fine. Cattle that are full fed on coarsely crushed ear corn spend considerable time separating the grain from the larger pieces of cob. Unless the cob is eaten, the time and labor spent in grinding would be employed to better advantage in shelling the corn for the cattle.

Comparison of Methods of Grinding Corn. The question of which type of mill to use for grinding either ear or shelled corn comes in for what seems an undue amount of discussion among cattle feeders It is true that small differences in consumption can be demonstrated, especially over short periods of time, if corn is ground coarsely or flaked by mills designed to grind corn in this manner. Such differences are, first of all, small, but in addition, these small differences in consumption may be more than offset by slower mill capacity and larger power requirements. Data such as those shown in Table 238 show that the type of mill used in grinding corn is not of great

Table 238

COMPARISON OF THREE METHODS OF GRINDING EAR CORN FOR FULL-FED YEARLING STEERS IN DRY LOT*

(September 1-October 27, 1954—56 days)

	Burr Mill	Hammer-mill	Reel-Type Knife Mill
Number of steers	10	10	10
Average initial weight, lb.	947	941	948
Average final weight, lb.	1,068	1,059	1,069
Average total gain, lb	121	118	121
Average daily gain, lb.	2.17	2.11	2 17
Average daily feed consumed, lb.			
Ground ear corn	17.1	17.4	17.1
Cottonseed meal	1.49	1.49	1.49
Mixed hay	3.6	3.6	3 6
Feed consumed per cwt. gain, lb.			
Ground ear corn	790.1	828.4	790.1
Cottonseed meal	68.8	70.4	68 8
Mixed hay	168.6	172.9	168.6
Feed cost per cwt. gain, $†	23.09	24 10	23 09
Cobs refused per day per steer, lb.	0 22	0 82	0
Average fineness moduli	4.33‡	4.20	4.30

* Illinois Feeders Day Report, 1954.

† Feed prices used: ground ear corn, $1.65 bu , cottonseed meal, $80 ton; mixed hay, $20 ton.

‡ Flour has a fineness modulus of 0 and particles larger than 3/8-inch are given a score of 7.

Table 240

A Comparison of Various Forms of Corn for Feeder Cattle*

(Average of Three Tests. Two-year-old Steers. Average Time Fed, 130 Days.)

Preparation of Corn	Broken Ears, pounds	Shelled Corn, pounds	Crushed Ear Corn, pounds	Corn-and-Cob Meal, pounds	Ground Shelled Corn, pounds
Average initial weight	971	983	973	981	980
Average daily gain	2.52	2.71	2.59	2.61	3.08
Average daily ration					
Corn (shelled basis)	17.42	17.87	17.21	17.10	18.33
Nitrogenous conc.	2.78	2.96	2.75	2.71	3.05
Corn silage	17.58	17.75	16.00	16.61	18.22
Legume hay	2.49	2.69	2.53	2.38	3.08
Feed per pound gain					
Corn (shelled basis)	6.80	6.57	6.58	6.48	5.95
Nitrogenous conc.	1.10	1.09	1.06	1.05	0.99
Corn silage	6.93	6.55	6.17	6.35	5.91
Legume hay	0.99	1.00	0.98	0.91	1.01
Beef per bushel corn fed cattle	8.24	8.52	8.51	8.64	9.40
Pork produced per steer	91.76	68.09	40.62	17.94	19.29
Pork per bushel corn fed cattle	2.27	1.63	1.01	0.46	0.45
Gain on cattle and hogs per bushel of corn fed cattle	10.51	10.15	9.52	9.10	9.85
Pounds of dry matter fed per pound gain on cattle and hogs	7.62	8.42	8.78	9.36	8.73
Per cent of total gain on cattle and hogs made by hogs	21.63	16.02	10.63	4.98	4.56
Per cent of corn fed recovered by hogs (based on estimate of 5 pounds corn per pound pork)	20.3	14.5	9.0	4.0	4.0

* Missouri Bulletin 149.

without making a number of qualifications. Most of the early experiments showed that shelled corn was somewhat superior in respect to palatability, rate of gain, and degree of finish produced, but several tests made more recently have raised serious doubts in regard to these points. For example, in the experiments reported in Table 239 calves and yearling cattle gained at nearly the same rate on shelled corn as on corn-and-cob meal. However, the steers in the Missouri experiments reported in Table 240 gained somewhat faster on shelled corn than on ground ear corn. In all the Ohio tests reported in Table 239, fewer bushels of corn were eaten per hundredweight gain by the steers

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A Comparison of Various Forms of Corn for Feeder Cattle*
(Average of Three Tests. Two-year-old Steers. Average Time Fed, 130 Days.)

Preparation of Corn	Broken Ears, pounds	Shelled Corn, pounds	Crushed Ear Corn, pounds	Corn-and-Cob Meal, pounds	Ground Shelled Corn, pounds
Average initial weight	971	983	973	981	980
Average daily gain	2 52	2.71	2.59	2.61	3 08
Average daily ration					
Corn (shelled basis)	17 42	17.87	17 24	17 10	18 33
Nitrogenous conc.	2 78	2 96	2 75	2 71	3 05
Corn silage	17 58	17 75	16 00	16 61	18 22
Legume hay	2 49	2 69	2 53	2 38	3 08
Feed per pound gain					
Corn (shelled basis)	6 80	6 57	6 58	6 48	5 95
Nitrogenous conc.	1 10	1 09	1 06	1 05	0 99
Corn silage	6 93	6 55	6 17	6 35	5 91
Legume hay	0 99	1 00	0 98	0 91	1 01
Beef per bushel corn fed cattle	8 24	8 52	8 51	8 64	9 40
Pork produced per steer	91 76	68 09	40 62	17 94	19 29
Pork per bushel corn fed cattle	2 27	1 63	1 01	0 46	0 45
Gain on cattle and hogs per bushel of corn fed cattle	10 51	10 15	9 52	9.10	9 85
Pounds of dry matter fed per pound gain on cattle and hogs	7 62	8 42	8 78	9.36	8.73
Per cent of total gain on cattle and hogs made by hogs	21 63	16 02	10.63	4 98	4 56
Per cent of corn fed recovered by hogs (based on estimate of 5 pounds corn per pound pork)	20 3	14 5	9 0	4 0	4 0

* Missouri Bulletin 149.

without making a number of qualifications. Most of the early experiments showed that shelled corn was somewhat superior in respect to palatability, rate of gain, and degree of finish produced, but several tests made more recently have raised serious doubts in regard to these points. For example, in the experiments reported in Table 239 calves and yearling cattle gained at nearly the same rate on shelled corn as on corn-and-cob meal. However, the steers in the Missouri experiments reported in Table 240 gained somewhat faster on shelled corn than on ground ear corn In all the Ohio tests reported in Table 239, fewer bushels of corn were eaten per hundredweight gain by the steers

fed ground ear corn, but in the Missouri experiments approxir the same amounts of corn were consumed per hundredweight o made. Such disagreement in the results obtained from thes forms of corn is frequently encountered in tests made at di stations or at the same station in different years or under di conditions. The fact that, in an Iowa test, ground ear corn pro significantly less gain than shelled corn with only 1 pound of l meal, but slightly larger gain with 2 pounds of protein suppl suggests that some of the corn-and-cob meal rations may hav tained insufficient protein to sustain the optimum bacterial acti the corn cobs during rumen digestion.[1]

When Is the Grinding of Corn Justified? A careful stu Tables 239 and 240 brings out the fact that whole corn produces meat, both beef and pork combined, than ground corn. This, w doubt, results from the inability of the swine to recover the particles of ground corn that pass through the cattle undig Unless the price of finished cattle is considerably higher tha price of swine, the grinding of corn is not ordinarily justified swine are available to follow the cattle. In the absence of medium or finely ground shelled corn should be fed, since the gains made by the cattle are more than enough to pay for the ex of grinding. (See Table 241.)

Obviously the cost of shelling, breaking, crushing, or grinding greatly with the kind and size of machinery used. A large an of corn can be ground or shelled at a much lower cost per bushel

Table 241

Advantages Resulting from Preparation of Corn*

	Increase in Cattle Gains per Bushel of Corn Fed	Value of Cattle Gains at 20 Cents per Pound	Increased Cost of Preparation per Bushel†	Shor of Ti Put lb.
1. Shelling ear corn	0.28 lb.	5.6¢	3–4¢	10
2. Crushing ear corn	0.27	5.4	5–6	4
3. Grinding ear corn	0.40	8.0	6–8	5
4. Shelling and grinding corn	1.16	23.6	8–10	27
5. Grinding shelled corn	0.88	17.6	5–7	17

* Computed from Table 240.

† Cost of breaking ear corn per bushel estimated at 4 cents.

[1] Iowa Experiment Station, AH Leaflet 165.

a single truckload. The greater the amount of man labor required to get the corn to and from the machine, the greater the cost.

One advantage possessed by ground corn over whole corn, especially over ear corn, is the ease with which it may be mixed with other feeds such as bran or the oilseed meals. Particularly is this mixing easy where self-feeders are used and a considerable quantity of feed is mixed up at one time. The self-feeding of oilseed meals along with broken ear corn is rather unsatisfactory since two materials varying so much in texture do not mix together well. With shelled or ground corn, however, no such difficulty is experienced. In the feeding of young, purebred breeding cattle and in the fitting of animals for the show ring, the use of ground or crushed corn is almost universal, largely because it is more easily mixed with the other components of the ration.

Ground ear corn is superior to shelled corn for cattle which are full-fed on legume pastures, such as red clover and alfalfa, because the dry particles of cob tend to overcome the tendency of these forages to cause scours and bloat. However, shelled corn appears to be much better on bluegrass and other non-legume pastures since larger quantities are eaten and therefore greater gains are secured. Shelled corn is less badly damaged by rain than is ground corn. It is therefore better suited for feeding out of doors and for use in self-feeders, which may have rain or snow blown into them during a severe storm.

One serious disadvantage of ground ear and ground shelled corn is the impossibility of storing it in quantity without its becoming unpalatable through the action of molds. These organisms develop rapidly in ground corn with a moisture content above 15 or 16 per cent at winter temperatures, or above 13 or 14 per cent at temperatures above 70° F. Since these limits are seldom obtained until late spring, it is usually necessary to grind corn every 3 or 4 days in order to prevent it from becoming musty and rancid before it is fed Shelled corn, on the other hand, can be stored safely if its moisture content does not exceed 18 per cent Consequently, shelled corn is preferred to either ground corn or ground ear corn by feeders who find it convenient to store large quantities of corn in the same form in which it will be fed.

Preparation of Oats, Barley, and Wheat. The advisability of grinding oats, barley, and wheat for cattle has already been discussed in Chapter 16. Inasmuch as the saving effected by grinding oats for calves usually does not exceed 5 to 10 per cent, grinding oats for animals of this age is not likely to be profitable unless oats are high in price. It is doubtful, however, that barley or wheat should ever

Table 242

VALUE OF GRINDING OATS, BARLEY, AND WHEAT FOR CATTLE

	Indiana Bulletin 371				Minnesota Bulletin 300		*Missouri Bulletin 325*		
Grain Ration	Oats, 1/3, Shelled Corn, 2/3				Barley (Alone)		Wheat Alone and Mixed with Corn		
	Whole Oats	Coarsely Ground	Medium Ground	Finely Ground	Whole	Ground	Whole Wheat	Ground Wheat	Ground Wheat½ Shelled Corn½
Initial weight, lb	997	997	993	995	693	687	562	554	557
Av. daily gain, lb.	1.93	2.06	2.11	1.95	2.12	2.25	2.16	1.84	2.57
Grain consumed daily	14.5	14.6	14.6	14.6	14.8	12.5	14.4	9.6	13.2
Grain per cwt. gain	*756*	*710*	*695*	*749*	*700*	*554*	*668*	*523*	*513*
Hog gains per steer	25	23	28	22	34	8	46	5	14
Feed cost per cwt. gain	$14.72	$14.00	$14.17	$16.06	$16.37	$13.89	$13.96	$12.16	$11.34

be fed whole because so many of the hard grains are swallowed whole and are imperfectly digested.

Preparation of Sorghum Grain. Threshed sorghum grains are generally so small and hard that they should be ground for cattle of all ages. Experiments with calves at the Texas station showed that grinding threshed milo increased its value 41 per cent and grinding unthreshed milo heads increased their value 62 per cent.[2] The unground grain was poorly utilized, as indicated by the fact that the swine gains per steer were approximately four times as great as those of the calves fed ground milo grain.

The results of digestion trials and feeding experiments carried out at the Kansas station with whole and ground milo are given in Table 243. In these trials no significant difference was observed between coarsely and finely ground milo grain. In a test at the Kansas station 42 per cent of whole milo grain fed to dairy cows was screened out of the feces, whereas the recovery of coarsely and finely ground milo grain was only 4.8 and 1.5 per cent, respectively, of the amount fed.[3]

The low digestibility of the grain of the sorghums lowers the feeding value of sorghum silage to a marked extent. An examination of the feces of cattle fed sorghum silage discloses that a high proportion of the seeds are voided with little evidence of their having been mas-

[2] Texas Bulletin 547.

[3] Kansas Mimeographed Report, May 1, 1918.

Table 243

EFFECT OF GRINDING UPON THE DIGESTIBILITY AND FEEDING VALUE OF MILO GRAIN*

Lot Number Ration	I Whole Milo, Atlas Silage, Cottonseed Meal	II Coarsely Gr. Milo, Atlas Silage, Cottonseed Meal	III Finely Gr. Milo, Atlas Silage, Cottonseed Meal
ion trial			
ge percentage of ıtrients digested:			
matter	48 0	52 3	60 2
le protein	42.7	46.8	54 9
er extract	50 1	64.7	72.5
le fiber	56 4	50 3	51 0
ogen-free extract	51.4	57.3	65.1
ıg trial, 122 days			
ge initial wt., lb.		540	540
in per steer, lb.		295	303
ily gain, lb.		2 42	2 48
er cwt. gain, lb.			
und milo		539	524
onseed meal		62	60
lfa hay		295	298
rie hay		282	256
ised value per cwt., $		29 00	30 00

ansas Experiment Station Circular 230.

ed. Experimental data on the subject are not available but it d appear that the large, soft-seeded grain of the newer hybrid ge sorghums would be more digestible than the grain of such a ge sorghum as Atlas sorgo.

lled versus Ground Grain. Crushed oats, barley, and wheat usually preferred to ground grains by professional herdsmen and ers of show cattle. Crushing is preferred to grinding because the are pressed into the kernels rather than split into fine slivers. ever, 2-year-old steers fed a grain mixture of equal parts of ed wheat and oats at the Illinois station[4] consumed less feed and e less rapid gains than steers fed ground oats and wheat. The n for these differences probably lay in the greater bulkiness of rushed grains, which occupied 40 per cent more volume per unit eight than the ground grains. In rations where bulk is desired, d grains are excellent feeds; however, their advantage over ground s would hardly justify the purchase of a crusher except in the of a very large herd.

imeographed Report, 1938.

Table 244

THE COMPARATIVE VALUE OF GROUND AND ROLLED GRAIN FOR FEEDER CATTLE

	Oklahoma Bulletin 270			*Illinois Mimeo.* Report, 1930	
	Whole Oats	Ground Oats	Rolled Oats	Ground Wheat and Oats 1:1	Rolled Wheat and Oats 1:1
Weight per bushel, lb.					
Oats	32.5	26	16	23.5	16.5
Wheat	.	.	...	52.5	39.5
Average initial weight, lb.	360	360	359	910	913
Average daily gain, lb.	2.11	2.14	1.82	2.36	2.15
Average daily ration, lb.					
Grain	7.2	6.9	6.1	15.0	14 0
Protein concentrate	2.0	2.0	2.0	2.1	2.0
Atlas sorgo silage	9.6	9.6	9.6	...	...
Clover hay	...	...	. .	5.2	5.2
Feed eaten per cwt. gain, lb.					
Grain	341	321	336	634	652
Protein concentrate	93	92	108	88	91
Atlas sorgo silage	452	447	525	...	...
Clover hay	...	..	.	219	240
Selling price per cwt., $				9.70	9.25

Rolled vs. Pelleted Grain. Pelleting or cubing of the grain alone, or of all the concentrate portion of the ration has received considerable attention in recent years. The Oklahoma study summarized in Table 245 shows that considerably less sorghum was required per unit of gain when the sorghum was pelleted instead of rolled, and gains were cheaper even though a much larger charge was made for pelleting than for rolling. One explanation might be that the smaller particles usually resulting from rolling or grinding sorghum grain were all saved because of being incorporated in the pellet. Still another possibility is that of a higher digestibility in the case of the pelleted grain. The advantage for pelleting would quite likely be even greater if compared with whole or finely ground sorghum grain.

Cooking Feed. The cooking of feed for beef cattle is seldom justified. Because cooking apparently increases the palatability of certain feeds, especially during cold weather, it is sometimes practiced in fitting cattle for the late fall and winter shows. Barley is the feed most commonly cooked. Its hard, flinty kernel becomes soft and

palatable after being soaked overnight and then steamed over a low fire for 2 or 3 hours. Special cookers may be purchased from livestock equipment supply dealers but most experienced herdsmen who use cooked feed devise their own cookers. Carefully conducted experiments show conclusively that cooking decreases the digestibility of most of the common feeding stuffs. This fact, together with the labor and fuel charges incident to cooking, makes this method of preparation entirely without merit for the practical cattleman.

Preparation of Roughage. During the last few years there has been much interest in the possibility of increasing the feeding value

Table 245

ROLLED VS. PELLETED MILO FOR FEEDER HEIFER CALVES*

Preparation of Milo	Lot I Medium Rolled	Lot II Finely Ground and Pelleted (⅜")
Number of heifers per lot	9†	10
Average weights, lb.		
Initial 10/26/57	498	497
Final 4/3/58	826	838
Av. daily gain	2.09	2.17
Average daily ration, lb.		
Rolled milo	11.96	
Pelleted milo		11.49
Cottonseed meal + stilbestrol‡	1.50	1.50
Dehyd. alfalfa meal pellets	1.00	1.00
Sorghum silage	11.58	10.77
2-1 mineral mix	0.10	0.06
Feed required per cwt. gain, lb.		
Milo	572	529
Cottonseed meal	72	69
Dehyd. alfalfa pellets	48	46
Sorghum silage	554	496
Feed cost per cwt. gain, $§	18.64	18.04
Financial results, $		
Total heifer and feed cost‖	175 69	175.76
Appraised value per cwt.	26.44	27.40
Total value per heifer	218.39	229.61
Net return over heifer+feed¶	42.70	53.85

* Oklahoma Livestock Feeders Day Report, 1958.

† One heifer removed from data for Lot I due to founder.

‡ Cottonseed meal fed per head daily contained 10 mg. stilbestrol

§ Charge of $0.10/cwt. for rolling; $0.25/cwt. for fine grinding and pelleting.

‖ Initial feeder price = $23 00 per cwt.

¶ No charge made for labor, equipment, spraying, trucking, or marketing.

of dry roughages by grinding or chaffing them. The presence of tractors and electric motors on most farms affords a source of power for driving feed grinders and hay chaffers, and manufacturers of this kind of equipment have sought to increase their sales by making profuse claims for the benefits to be obtained by feeding ground hay and fodder. Fortunately for the farmer who takes the pains to learn the facts before spending his money, a great deal of information is available which indicates that the grinding of roughage is seldom a profitable practice in the feeding of beef cattle. It is true that ground or chaffed hay and stover are fed with less waste than they are in their natural forms and that ground roughage may be stored more easily under cover. However, unless roughage is scarce and expensive the cost of grinding is usually much greater than the saving made. As a rule, the money and labor expended in grinding roughages could be much better spent in harvesting sufficient amounts of hay and fodder to permit the cattle to eat only the more palatable and digestible portions and not the woody stems and butts, as they must do if these roughages are cut or ground.

Grinding and Chaffing Hay. The claim that the feeding value of hay is improved by grinding is not supported by most of the tests which have been made with long and ground hay. (See Table 246.) Instead, these tests have shown that cattle often do not like ground hay, that the feeding of ground hay decreases the time spent in rumination, and that, as a result of the reduced consumption and less thorough digestion of the ground roughage, the gains are smaller and more costly.

The practice of grinding the hay and feeding it mixed with the grain has in some tests resulted in larger gains than when whole feeds were fed, but in a number of experiments opposite results have been obtained. In few, if any, of the tests have the advantages been sufficient to pay for the expense of grinding and mixing the feeds, especially if the gains made by the swine kept with the cattle are taken into account.

Apparently the principal advantage possessed by ground hay over long hay is that it is fed with less waste. Cattle fed long hay often pull some of it out of the manger and trample it under foot. Also, they usually leave some of the stems uneaten, particularly if the hay is full-fed. Obviously, both of these losses are greater if the hay is coarse and poor in quality. Since only hay of poor quality is fed with appreciable waste, it is this kind of hay that is most frequently ground. Even if the waste of the long hay were as much as 25 per cent, it is doubtful if grinding would be profitable because the coarser

Table 246

VALUE OF GRINDING OR CHAFFING HAY FOR FEEDER CATTLE

	Nebraska Mimeo. Cattle Circular 157 Two Trials		Iowa Mimeo AH Leaflet 162			Minnesota Bulletin 300	
	Shelled Corn and Alfalfa Hay		Shelled Corn and Alfalfa Hay			Ground Shelled Corn and Alfalfa Hay	
	Long Hay Fed Separately	Ground Hay Mixed with Corn	Long Hay Fed Separately	Coarsely Chopped Hay Mixed with Corn	Finely Chopped Hay Mixed with Corn	Whole Hay Fed Separately	Ground Hay Mixed with Corn
Av. initial wt.	611	610	692	690	690	688	689
Av. daily gain	2.20	2 15	2 35	2.40	2 35	2 49	2 52
Av. daily ration							
Corn	13 5	13 8	15 7	15 3	14 8	17 0	17 2
Protein supplement	..	..	1 0	1 0	1.0	.	
Hay*	5 5	3.5	4.6	4.6	4.5	7 0	6 4
Feed per cwt. gain							
Corn	616	642	667	636	629	682	684
Protein supplement	.	.	42	41	42		
Hay	250	162	196	192	194	279	256
Feed cost per cwt gain	$11.29	$11 01	$15 02	$14 41†	$14.34†	$10 52	$10 48
Selling price per cwt	9 80	9 80	17.15	17 00	16 85	12 00	12 00
Net return per steer	.	.	30 50	32 93†	29 90†	30 10	30 37

* Including hay that was wasted.
† Cost of chaffing hay not included.

portions which constitute most of the waste usually are worth much less than the cost of grinding the whole supply of hay fed.

If hay is so scarce and expensive that its waste must be prevented more than is possible through the use of properly built racks and mangers, it should be cut or chaffed by running it through a silage cutter or similar machine which cuts it into 2- to 4-inch lengths Chaffed hay is better digested by ruminants than ground hay and is prepared with much less labor and power.

One of the advantages of chaffed or chopped hay is the low cost of harvesting and storage. If it is chopped from the windrow with a field cutter and blown into the barn where it can be "pushed down" to the cattle with little or no handling, less labor is required than in harvesting and feeding long or baled hay. (See Fig 94.) Also, approximately twice as many tons of chopped as of long hay can be stored in a given shed or mow. However, hay that is to be chopped in the field must be much drier when stored than ordinary hay or hay that is stored in the bale. Consequently a rather high percentage of the leaves and fine stems are reduced to such fine particles by the

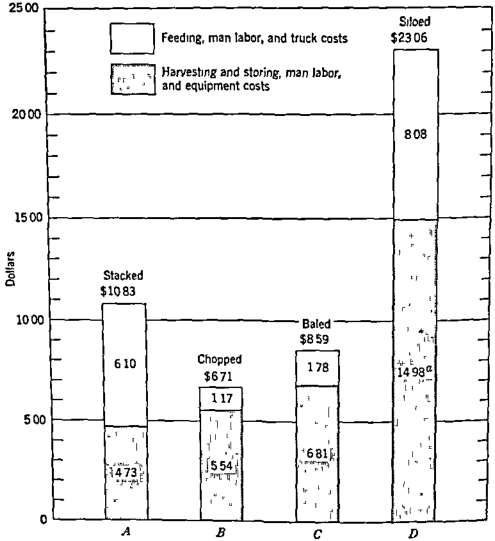

FIG. 94. Effect of method of harvesting and storing upon the cost per acre of harvesting and feeding the first cutting of alfalfa. (*A*) Stacked in field with bull rakes and overshot stackers; hauled to cattle about once a week; usually hay was the only feed fed. (*B*) Chopped from windrow; hauled from field in trucks and stacked near feed lot; fed mixed with grain in grain bunks. (*C*) Baled from windrow with pick-up balers; bales picked up with tractor and sled and piled in the field or near the feed lot; fed by breaking bales and scattering hay in grain bunks. (*D*) Ensiled alfalfa was either mowed and chopped in one operation or mowed and windrowed and chopped from windrow; hauled in trucks to upright or trench silos; usually a preservative was added as the silo was filled; alfalfa silage fed mixed with grain to beef cattle; fed alone to dairy cows after milking. (From data in Colorado Bulletin 417-A.)

chopper and blower that they are lost in harvesting and feeding. The storage of chopped hay with a moisture content much above 15 per cent usually results in the loss of valuable food nutrients from extensive "mow burning." There is also the risk of losing both hay and barn from spontaneous combustion. Consequently the field chopping of hay can be recommended only when it is to be stored in a barn or bin equipped with forced ventilation. When so stored it may be chopped while it is still sufficiently "tough" to prevent the loss of valuable leaves and stems, since the excess moisture is driven off by the forced ventilation before serious heating occurs.

In the final analysis, the method of harvesting and storing roughage matters little to cattle being fed on finishing rations, as will be seen in Table 247. After all, roughage makes up only about 20 to 30 per cent of the total ration consumed. Therefore the method used in harvesting a hay crop which is fed largely to feeder cattle is determined by the relative cost of the various methods of harvesting.

Effect of Grinding and Chopping Roughage upon Its Palatability. It might seem that ground or chopped roughage would be more palatable than whole roughage since it can be eaten more easily. Also, all the ground roughage fed is usually eaten, whereas a noticeable percentage of whole hay or stover is refused. With coarse, stemmy hay and corn stover the refused portion may amount to 20 to 40 per cent of the total amount fed.

Table 247

THE EFFECT OF METHOD OF HARVEST AND STORAGE OF ALFALFA HAY UPON ITS VALUE FOR FEEDER CATTLE*

(Average of 3 Trials)

	Stacked Alfalfa Hay	Baled from Wind-row	Chopped from Wind-row	Dehydrated Alfalfa Hay	Molasses-Alfalfa Silage
Av. initial wt., lb.	696	692	689	694	717
Av. daily gain	2.04	2.11	2.13	2.19	2.09
Av. daily ration					
Grain	15.5	15.6	15.4	15.5	15.8
Soybean oil meal	1.0	1.0	1.0	1.0	1.0
Hay or silage	3.6	3.9	3.9	3.5[a]	9.5[a]
Feed per cwt. gain					
Grain	773	756	738	724	777
Soybean oil meal	48	47	46	45	47
Hay or silage	177	187	183	155[b]	453[b]
Av. TDN per cwt. gain	712	705	689	669	702

* Colorado Experiment Station Progress Report, February, 1951.

[a] Includes approximately 0.5 lb. of long stacked hay.

[b] Includes approximately 20 lb. of long stacked hay

Feeding experiments show, however, that cattle usually eat more whole hay than ground or chopped hay if both kinds are fed according to appetite. For example, in the Nebraska experiments reported in Table 246 it was necessary in both trials to limit the feeding of whole hay in order to obtain the desired consumption of corn, whereas some difficulty was experienced in getting the lots fed ground alfalfa to eat their hay. Likewise in palatability tests conducted at the Wisconsin station with purebred beef cows and heifers a marked preference for whole hay and coarsely chopped hay (1.8 inch) and a dislike for hay chopped to ½ inch and ¼ inch were noted. In one of the Wisconsin tests, where all four kinds of hay were available in adjacent mangers, whole hay constituted 71.5 of all the hay consumed.[5]

"Predigested" Feeds. Some manufacturing concerns have advocated the predigesting of coarse feeds before feeding by subjecting them to bacterial action which presumably breaks down the fiber and cellulose into soluble, easily digested starches and sugars. Such changes were to be brought about by treating the chopped or ground roughage with a special "converter" or "digester compound" having powerful enzymic properties, then steaming the mixture in a special container, and letting it stand for 24 hours before feeding it to the cattle. By adding fresh material at the top of the chamber as the "converted" roughage was withdrawn at the bottom, a *continuous* supply of feed would be made available. Fortunately for those feeders who appear to be continually looking for some magic way to prosperity, experiment stations quickly investigated the new process and found it to be without merit. "There was no advantage to this method of preparation as compared to feeding dry roughage. Salt was fully as efficient as the digester compound. Steaming the roughage did not help in this test."[6] Following the publication of the findings of these investigations, interest in this method of preparing feeds rapidly subsided.

Pelleting of Beef Cattle Feeds. The pelleting or cubing of roughages or of complete rations by forcing, with great pressure, the finely ground feedstuffs through dies varying from ¼ to 1 inch in diameter, is being heralded as one of the great developments of the past decade. The advantages usually listed for this rather costly method of preparing beef cattle feeds are:

1. Easier handling because of reduced bulk.
2. Increased feed intake, especially of lower quality roughages.

[5] *Shorthorn World*, Sept 25, 1947, p 46

[6] Ohio Agricultural Experiment Station Circular 10.

3. Improved feed conversion rates.
4. Increased rate of gain on high roughage rations.
5. Control of ratios of concentrate to roughages at the desired level.

Pelleting Hay. Of all the various components of a beef cattle ration, the roughage portion would be most *affected* by pelleting from the standpoint of storage and labor of feeding. The bulkiness of roughage also is the limiting factor from the standpoint of intake or level of consumption by beef cattle. Thus it appears that pelleting of roughage should offer more promise than the pelleting of concentrates. Several tests have recently been conducted with pelleted roughages, with conflicting results. The Illinois Dixon Springs Experiment Station conducted two tests with an all-hay ration for stocker calves and the results are overwhelmingly in favor of pelleting, as may be seen in Table 248 which summarizes the first test. In this test the hay fed was a first-cutting mixed hay of average to poor *quality consisting of two-thirds timothy and one-third alfalfa.* Prior to pelleting into $\frac{3}{16}$-inch pellets the hay was finely ground. No molasses or steam was used in the pelleting process and, as the data in Table 248 show, daily consumption of ration was greatly improved by the pelleting.

The second trial produced similar results with poor-quality alfalfa, with Serecia lespedeza, and again with a timothy-alfalfa mixture. As would be expected, some of the advantage of the more rapid winter gains made by the calves on pelleted hay was lost during the subsequent summer grazing period. However, the situation was no

Table 248

COMPARISON OF TIMOTHY-ALFALFA MIXTURE WHEN FED CHOPPED, PELLETED, OR AS LONG HAY*

(119 days)

Method of Hay Preparation	Baled	Pelleted	Chopped
Number of steers	15	15	15
Av. initial weight, lb.	421	430	423
Av. final weight, lb.	496	636	497
Av. daily gain, lb	0.63	1 73	0.62
Daily feed consumption, lb	11 0	15.7	10.7
Feed required per cwt. gain, lb	1,732	906	1,722
Feed cost per cwt. gain, $	17.32†	13 59	17 22
Gain per ton of feed, lb.	115.5	220 7	116 2

* Illinois Dixon Springs Mimeograph, DS-40-329, 1958.

† Feed prices used: Baled and chopped hay, $20 per ton, pelleted hay, $30 per ton.

Table 249

EFFECT OF PELLETING ROUGHAGE FOR BEEF CALVES*

Feeding System	Roughage Full-Fed		Roughage Controlled	
Lot Number	1	2	3	4
Roughage Form	Pelleted	Chopped	Pelleted	Chopped
Number of calves per lot	6	6	6	6
Days on feed	108	108	108	108
Average weights, lb.				
Initial 11/8/57	410	405	410	413
Final 2/24/58	589	613	578	592
Total gain	178	207	168	178
Average daily gain	1.65	1.92	1.56	1.65
Average daily feed consumption, lb.				
Roughage	15.3	15.1	11.2	11.2
Concentrate	3.7	3.7	3.7	3.7
Total	19.0	18.8	14.9	14.9
Feed per cwt. gain, lb.	1,155	983	956	902
Feed cost per cwt. gain, $	19.63†	13.58	16.85	13.19

* Oklahoma Livestock Feeders Day Report, 1958.

† An additional cost of $6.00 per ton for pelleting the roughage fed to Lots 1 and 3 *was used in arriving at feed costs per cwt. gain.*

different from any two droves of steers which make different rates of winter gain. It should be mentioned that the roughages fed in these tests were of only poor to average quality, but at the same time much of the hay fed in any but the mountain and western states is of similar quality.

An Oklahoma test with stocker calves which received about 4 pounds of concentrates and a roughage mixture containing equal parts of good-quality alfalfa hay and cottonseed hulls plus 5 per cent molasses resulted in a different answer as to the value of pelleting. The comparison was confined to chopped and pelleted roughage, but the test was so designed that comparisons might be made under both full-feeding and controlled equal-feeding conditions. Table 249 shows that pelleting decreased gains and increased the amount of ration required per unit of gain.

In another test at the same station in which calves had an opportunity to eat the above ration in either pelleted or chopped form, they showed a preference for the pelleted feed, consuming 2.2 times as much pelleted as chopped roughage.

Even if further tests reveal that pelleting roughages for beef cattle

is advantageous it will be necessary for hay-harvesting equipment manufacturers to develop a portable pelleting machine which can chop and pellet the hay out of the swath in the field if this method of harvesting and storing hay is to become a common practice. The matter of excess moisture in hay for safe storage as pellets also presents a problem which may be solved only by the addition of drying units to the pelleting machine. The cost of such a complex machine quite likely would be such that individual farmers could not afford them. For large commercial feed lots which buy their roughage in the neighborhood, this method of harvesting and feeding roughage shows promise but it is doubtful if the average or small feeder will be pelleting roughages in the near future.

Pelleting Complete Rations. Increased mechanization of feed-handling in cattle feeding has resulted in interest in complete mixed rations. Roughages in chopped form, either dry or as silage or green

Table 250

COMPARISON OF FEEDING A RATION AS PELLETS AND AS A MEAL TO YEARLING STEERS (130 days)*

Lot Number	1	2	3
	Pellets	Meal	
Form of Ration	Self-Fed	Self-Fed	Hand-Fed
Number of steers	18	18	18
Average initial weight, lb.	651	646	653
Average final weight, lb.	1,008	981	969
Average total gain, lb.	357	335	316
Average daily gain, lb.	2 75	2.58	2 43
Average daily ration, lb.			
Concentrate and hay†	20.0	21.0	20.4
Corn silage	12 1	11.9	13 0
Feed eaten per cwt. gain, lb.			
Concentrate and hay	729	845	840
Corn silage	442	463	534
Cost of feed, $	60.20‡	64.63	61.80
Cost of feed per cwt. gain, $	16.86	19 29	19 56
Sale weight, lb.	947	937	923
Shrink, lb.	61	44	46
Farm value less cost of steer and feed, $	29 03	20.93	14.64
Dressing per cent	58 5	58.5	59 0

* Illinois Dixon Springs Mimeograph, 40-329, 1958

† The pellets or meal consisted of 65% ground ear corn, 5% blackstrap molasses, 10% soybean oil meal, and 20% ground alfalfa hay.

‡ Feed prices: ear corn, $1.40 per bu., soybean meal, $75 per ton, molasses, $34 per ton; hay, $24 per ton, corn silage, $10 per ton No charge was made for pelleting

chop, are often mixed with the concentrate portion of the ration for feeding with automatic unloading wagons or in various types of conveyor or auger bunks. Naturally the idea of pelleting the whole ration, where dry roughages are used, is an interesting one which offers the possibility of simplifying the feeding operation considerably.

As with pelleted all-roughage rations, the Illinois Dixon Springs Station has done some interesting pioneer work with complete pelleted rations. Table 250 shows the result of a 130-day test in which a complete ration is compared when fed in pelleted and in meal form. The steers fed on pellets gained faster and more efficiently.

Pelleting of the complete ration may make it possible to increase the total amount of roughage in the ration without reducing performance on the part of the steers. If this should finally prove to be true after more extensive testing, costs of gain could be reduced because good roughages generally are a more economical source of total digestible nutrients or energy, pound for pound, than concentrates.

Table 251 is a summary of another Dixon Springs station test in which rations with various ratios of concentrate to roughage were compared when fed in pelleted form. Note that increasing the roughage from 25 to 35 per cent of the ration did not change performance

Table 251

RESPONSE OF YEARLING FEEDER STEERS SELF-FED COMPLETE PELLETED RATIONS OF VARYING RATIOS OF CONCENTRATE AND ROUGHAGE*

	Lot 1	Lot 2	Lot 3
Number of steers	15	15	15
Pelleted ration, %			
Timothy-alfalfa hay	25	35	45
Ground shelled corn	65	55	45
Soybean oil meal	10	10	10
Average initial weight, lb.	703	700	698
Average final weight, lb.	1,145	1,137	1,112
Average daily gain, lb	2.80	2.85	2.71
Av. daily pellet intake, lb	21.5	22.8	23.0
Pellets required per cwt. gain, lb.	745	800	851
Cost of pellets per cwt. gain, $	17.20†	17.49	17.58
Sale price per cwt., $	21.00	21.00	21.00
Farm value of steer less feeder steer and feed cost, $	15.63‡	16.00	13.53

materially and that, even when the roughage content of the ration was increased to 45 per cent, reduction in rate of gain was not serious.

As in the case of pelleting all-roughage rations, pelleting of the complete ration as a general farm feedlot practice awaits further developments on the part of the processing equipment manufacturers Some of the commercial feed lots are already pelleting their complete rations with satisfactory results, but it should be emphasized that capital investments in costly equipment can be spread out over a far greater number of cattle in such operations than is possible in the case of farm or ranch feeders.

Self-Feeding vs. Hand Feeding. The use of self-feeders in finishing cattle is very common, especially for cattle that are given a short feed before being marketed. Because such animals are on a full grain ration during almost the entire feeding period, the self-fed method of feeding is in many ways advantageous. On the other hand, self-feeders are manifestly impractical for an extended feeding period during most of which something less than a full feed of grain is used

The principal *advantages* derived from the use of self-feeders are as follows:

1. There is a saving in the time and labor expended in feeding.
2. Larger daily gains are secured.
3. The cattle are less likely to go off feed.

Of these advantages, the saving of labor is by far the most important. By using self-feeders with large bins or hoppers, it is necessary to feed the cattle only once every week or 10 days. Large quantities of feed can be prepared by the use of machinery and delivered directly into the feeders with self-unloading wagons, with a minimum of time and labor. Still more convenient is the practice of grinding directly into the self-feeder so that almost all handling of grain is eliminated.

Hand feeding, on the other hand, requires the preparation of each feed at the time it is fed, or the rehandling of the material if it is prepared in quantity and stored. This saving of labor is of most consequence to the farmer during the summer months when he is busy in the field and begrudges the time spent in doing morning and evening chores. For this reason, self-feeders are more extensively used in summer than in winter feeding.

Carefully conducted feeding experiments indicate that self-feeding usually results in larger gains than hand feeding. This is usually true even when the hand feeding is carefully done at regular intervals by experienced feeders Under ordinary farm conditions, with frequent irregularity in the time of feeding, quantity and character of rations,

time, or to eat as rapidly as possible in order to get their share before all the feed is gone.

Care must be exercised, of course, in putting cattle on a self-feeder. As a rule, hand feeding is practiced until the cattle are accustomed to a full feed of grain. This period may vary from a week to 60 or even 90 days, depending on the length of the feeding period.

The principal *disadvantages* of using self-feeders are the following:

1. It is impossible to utilize large amounts of farm-grown roughages.
2. Large amounts of high-moisture grain cannot be prepared at one time.
3. A larger investment in equipment is required.
4. There is a slight increase in cost of gains.
5. Cattle are apt to be less carefully observed.

None of these items requires any extended discussion. With regard to the first, it is freely admitted that self-feeders have no place on those farms where the grain ration is more or less limited with a view to utilizing large quantities of roughage.

If a nitrogenous concentrate is to be fed in a self-feeder along with the corn, the corn should be either shelled or ground because the common protein feeding stuffs cannot be mixed with ear corn satisfactorily. A somewhat better mixture results with ground corn than with shelled. In all cases, of course, sorghums must be ground. If the moisture content of either ground ear corn, ground shelled corn, or sorghum is much over 15 per cent in winter or 13 per cent in summer, molding is apt to occur in the self-feeder. If the feeder is used on pasture a certain amount of rainwater is almost bound to get into the self-feeder, resulting in the same problem as when the corn is ground with above-normal moisture content.

Self-feeders are somewhat more expensive to build than ordinary troughs and bunks Moreover, the former do not entirely replace the latter, since wide-open bunks are more satisfactory than the troughs along the sides of the feeders for getting the cattle on full feed. Such bunks are also necessary for the feeding of silage. However, the cost of both bunks and self-feeders is relatively small, so that the increased investment due to duplicate equipment is not a serious matter.

It is rather generally believed that hand feeding results in more economical gains than can be obtained from self-feeding Granting that this may be true when the hand feeding is carefully done, this advantage is not likely to exist when the ordinary methods of hand feeding are practiced. Inasmuch as nearly half of the experiments involving hand-fed and self-fed lots show a slightly lower feed require-

et cetera, the difference in favor of self-feeding is as a rule greater than the results obtained in experimental trials in which these two methods have been compared.

Next in importance to the saving of labor is the value of the self-feeder in lessening the tendency of the cattle to go off feed. "Going off feed" is due principally to overeating. The appetites of animals are affected greatly by weather conditions, and cattle that are hand-fed frequently come to the feed trough with much keener appetites than they ordinarily possess. The result is that some of the larger and stronger steers eat more than their share, bolting the greater part of the feed without much chewing. On the following day these cattle are likely to be "off feed." The usual symptoms are partial loss of appetite and pronounced scouring. The customary method of treatment is to cut down the feed to about one-half the usual amount, to favor the correction of the digestive disturbance. Although this treatment is perhaps as good as any practical means that can be devised, it is likely to cause a recurrence of the trouble unless great care is exercised in bringing the cattle back to their normal ration. They should be brought back as rapidly as their recovery of appetite permits. However, the ration should be increased gradually to guard against overeating by steers that are ravenously hungry.

Cattle that are self-fed show comparatively little tendency to go off feed. They soon learn that the feed is accessible at all times and consequently they eat in a leisurely manner and only enough to satisfy the appetite which they feel at the moment. There is no inclination to gorge themselves with enough feed to last until the next feeding

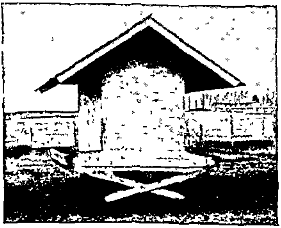

FIG. 95. A satisfactory type of self-feeder. It is filled through a window in the opposite end. (University of Illinois.)

time, or to eat as rapidly as possible in order to get their share before all the feed is gone.

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Table 252

COMPARISON OF SELF-FEEDING AND HAND FEEDING STEERS

	Wisconsin, Mimeograph Report, 1929 168 Days			Iowa Bulletin 182 Average of 2 Trials 1st 120 Days		Iowa Bulletin 182 Average of 2 Trials Total Period First Trial 160 Days Second Trial 150 Days	
	Fed Twice-a-Day	Fed Once-a-Day	Self-Fed Corn; Other Feeds Fed Once-a-Day	Self-Fed	Hand-Fed	Self-Fed	Hand-Fed
Av. daily gain	2.51 lb	2 56 lb.	2.55 lb.	3.24 lb.	3 06 lb.	2.94 lb.	2.68 lb.
Av. daily ration							
Corn	12 4	12 4	12.8	15 15	14.47	16 14	15 00
N conc.	1 50	1 50	1.50	2.25	2.25	2.25	2.25
Legume hay	2.0	2.0	2.0	1.44	1.44	1.28	1.28
Corn silage	17.1	17.1	17.1	32.47	31.43	29.24	28.74
Feed per lb gain							
Corn	4.95	4.86	5.00	4.71	4.76	5 55	5 64
N conc.	0 60	0.58	0.59	0.69	0.73	0.77	0 84
Legume hay	0 80	0 79	0.79	0 45	0 47	0.44	0 48
Corn silage	6 79	6 66	6.68	10 04	10 27	10 00	10.78

ment per pound of gain with self-fed lots, we may draw the conclusion that no material difference exists between these methods of feeding insofar as the cost of the gains is concerned. (See Table 252.)

It is difficult to place a monetary value on good husbandry in full-feeding feeder cattle, but the old adage "The eye of the master fattens his cattle" is undoubtedly an important factor in the success or failure of this cattle program. The use of self-feeders tends to encourage a lackadaisical attitude toward the well-being of feeder cattle because close observation and actual contact with the cattle each day are not essential.

The Free-Choice Method of Feeding. The placing of several different kinds of feed in separate feeders, from which the animals may eat as much or as little of each as their appetites prompt them, is termed the "free-choice" method of feeding. Although this method is used extensively in the fattening of swine, it is only rarely practiced in the feeding of cattle. The theory underlying the free-choice plan is that the appetite of the animal is the best possible guide as to the kind and quantity of feeds that it needs. This theory is in the main sound, as suggested by the data in Table 253, obtained from a number

Table 253

SELECTION OF FEEDS BY BEEF CALVES FED "FREE-CHOICE" IN DRY LOT AFTER WEANING*

	Lot 1: Not Creep Fed	Lot 2: Creep Fed before Weaning	Average of 7 Lots, 3 Creep Fed, 4 Not Creep Fed
Hand fed after weaning, days	4	None	3 hand fed 56 days 1 hand fed 4 days 3 not hand fed
Av. initial weight, lb.	398	418	398
Time fed, days	173	173	167
Av. daily gain, lb.	2.10	1 99	2 11
Av. daily ration			
Shelled corn	7.3	8 0	5.4
Oats (whole)	4 9	4 7	4 4
Cottonseed cake (43%)	1 2	6	1 3
Prairie hay	1 3	1 2	1 1
Alfalfa hay	0 8	0 8	1 2
Nutritive ratio	1:6 4	1:7 5	1 6
Feed consumed per cwt. gain			
Concentrates	641	668	523
Hay	100	97	106

* Oklahoma Bulletin 262.

of feeding trials carried on at the Oklahoma Experiment Station with calves after they were weaned. Although the calves had free access to cottonseed meal, no more of this feed was eaten than was needed to balance the ration. In this respect the Oklahoma results differ from those obtained at the Iowa station[7] where, in a similar test, calves ate approximately as much protein concentrates as grain when all components of the ration were fed "free-choice."

A test has recently been conducted at the Ohio station to answer questions relative to the advisability of self-feeding the roughage separately from the self-fed grain, as compared with self-feeding the complete ration. The pertinent results concerning this comparison, as well as the results of self-feeding pelleted roughages and of self-feeding a soybean meal plus 5 per cent salt mixture, are given in Table 254. Feeding methods used in Lots 1, 4, and 5 produced equal results and indicate that when similar rations are fed it makes little real difference which method of feeding is used. The fact that the soybean oil meal plus 5 per cent salt mixture was consumed at about the desired level is encouraging because this system of feeding the protein concentrate makes it possible, as well as more convenient, to

[7] Iowa Mimeographed Report of Calf Feeding Tests.

Table 254

A COMPARISON OF METHODS OF FEEDING FEEDER CATTLE*

(252 days)

	Complete Mixture Self-Fed	Alfalfa Hay, Corn, Self-Fed	Alfalfa Pellets, Corn, Self-Fed	Hay, Corn, Soybean Meal-Salt Mixture Self-Fed	Hand-Fed
Lot number	1	2	3	4	5
Steers per lot	7	7	7	7	7
Av. initial weight, lb.	479	480	485	483	484
Av final weight, lb.	986	945	952	1,003	988
Av. daily gain, lb.	2.01	1.85	1.85	2.06	2.00
Av. daily ration:					
Ground ear corn, lb.	11.8	10.7	12.8	11.4	10.5
Soybean oil meal, lb.	1.6			1.3	1.5
Corn silage, lb.	3.8	5.0	4.4	5.3	7.4
Mixed hay, lb.	2.1			4.2	2.1
Alfalfa hay, lb.		5 0	3.0		
Minerals, oz.	0.5	1.0	1.1	0.3	0.5
Salt, oz.	0.5	0.4	0.6	0.7	0.2
Feed req. per cwt. gain, lb.					
Ground ear corn	588	580	692	551	526
Soybean oil meal	77			61	75
Corn silage	189	268	240	258	370
Mixed hay	106			201	103
Alfalfa hay		271	160		
Minerals	2	3	4	1	1
Salt	2	2	2	2	1
Feed cost per cwt. gain, $	16 79	16.44	17.99	17.02	16.32
Dressing percentage	64.2	61 9	63.8	62.9	63 0
Live value per cwt., $	23 85	22 89	23.75	23 36	23.47

* Ohio Cattle Feeders Day Report, 1957.

use automatic grinding and filling of the self-feeder without worrying how to meter in the protein concentrate in the correct amount.

Details of Hand Feeding. COMBINING FEEDS. As a rule, grain and other concentrates should be fed separately from the roughage. Exceptions occur in the case of cattle that are fed silage or complete pelleted rations. When silage is fed, the silage should be put into the trough first and the grain and protein concentrate poured over it unless the new auger bunks are used. If the grain is self-fed, the protein concentrate should be spread over the silage instead of fed with the grain. Where silage is not fed, all concentrates used, including grain, should be fed mixed together.

Roughages, on the other hand, should be fed separately if more than one is fed. In the first place it is almost impossible to make an even mixture of such bulky materials. Second, mixing is likely to decrease the total consumption of roughage through the enforced consumption of the less palatable or more bulky feeding stuff. For example, the mixing of cut straw and silage at the Illinois Experiment Station resulted in a lower consumption of roughage than was obtained by feeding the two separately.

Number of Feeds per Day. Considerable variation exists among practical cattle feeders as to the number of times the different constituents of the ration are fed each day. Sometimes the cattle are fed only once a day and are given enough of every item to supply them for the next 24 hours. (Should the practice be to offer a surplus of feed so that feed is before the cattle at all times, hand feeding no longer exists, even though the usual self-feeding equipment is not used.) Although feeding only once a day saves much time and labor it is not likely to bring about as good results as the feeding of smaller quantities at shorter intervals. This statement applies to the grain rather than the roughage, particularly if more than one kind of roughage is used.

Two feedings per day is the usual number, though the most careful feeders, such as the men who fit cattle for exhibition or who let pass no opportunity to "top the market," give three or even four feeds of grain. The advantage of the larger number is that frequent feedings stimulate the appetites of the cattle by supplying fresh, clean feed that has not been "mussed over." Also, at each feeding time the curiosity of the animals is aroused, and they come up to the troughs to see what they have been given.

When two feedings per day are made they should be given fairly early in the morning and late in the evening. The exact time of day depends upon the season of the year. Cattle should not be disturbed before daylight, at which time they usually begin to stir about, nor should they be fed so late in the evening that they will not finish eating shortly before dark. With three feedings, the second one should be made at noon; with four, the last one should be given about 9 o'clock at night. Four feedings are impractical except in the case of show animals or unless automatically timed auger feeders are used. Show cattle are usually fed in barns where each one can be fed separately, in which case it is comparatively easy to judge the exact amount of feed that each animal should have.

Seldom are more than two feeds of roughage given per day. If more than one roughage material is used it is a common practice to feed

one in the morning and the other in the evening. The less palatable material should be fed in the morning so as to afford a longer time for its consumption. When silage and a legume hay are fed, the former may be fed in the morning and the latter at evening, since, as a rule, more silage than hay will be used; or both silage and hay may be fed in the morning and only silage at evening.

No hard and fast rules can be laid down concerning either the best time or the best method of feeding. They necessarily must be determined largely by the location of the feed supply in reference to the cattle and the amounts of the different feeding stuffs used. It is obvious that the more labor involved in feeding a given material, the greater is the likelihood that a single feeding per day will give the best results.

chapter 27
BUILDINGS AND EQUIPMENT FOR BEEF CATTLE

Reductions in capital investment in buildings and equipment and in labor required per unit of beef produced or per head fed have not kept pace with the improvement in the feeding and breeding of beef cattle. This statement is especially true when labor costs in the beef enterprise are compared with those connected with the production of such other species as poultry or swine, or when compared with labor requirements involved in crop production. Recent studies by the United States Department of Agriculture show that crop labor requirements per unit of production have been reduced by 34 per cent since 1939. This reduction has amounted to only 7 per cent for livestock enterprises, and it is doubtful if the beef enterprise would equal the average in this respect.

On the average, 10 to 12 man hours of labor are required to feed and care for a single feeder steer, carried through a normal feeding program in the Corn Belt area. The largest single labor requirement is that of feeding, especially in the stocker and feeder programs. Therefore, any material reduction in labor requirements occurs only when the feeding problem is looked upon as a materials-handling problem. Efficient shed and feedlot layouts are the first step toward reducing labor requirements, followed closely by the use of carefully chosen mechanical feed-processing and handling machinery. When building either a new set of beef cattle buildings and feed lots, equipped with the latest in new equipment, or when remodeling older improvements, the farmer or rancher must bear in mind that most of the new capital investment must be paid for out of labor savings, and the amount that can be saved per animal unit is very small. Thus either the capacity of the feed lot must be large, with year-round feeding operations going on so as to spread the cost over a large number of head, or the initial investment must be minimal The great interest in mechanization, with all its possible combinations of handy feeding systems, may lead some cattlemen to over-build Actually, in the

handling of beef cattle, comparatively little equipment is needed. This is especially true of stockers and feeders. Purebred animals, on the other hand, usually are afforded shelter and equipment somewhat more pretentious, although even here the investment in equipment need not be large. However, on the farms of the larger, wealthier breeders it often amounts to several hundred dollars per head in the herd. Much of this extra investment is in the form of buildings, apparatus, and devices that make for a more efficient management of the herd and reduce the amount of labor required for its proper feeding and care.

A brief discussion of the more important articles of equipment found useful on beef cattle farms will be attempted for the benefit of the reader who is unfamiliar with their use.

Shelter. A satisfactory shelter for beef cattle is one that furnishes adequate protection from wind and rain. Protection against cold is not necessary in any but the northern latitudes, except for young calves. Numerous experiments carried on with full-fed steers indicate that such cattle do better in open sheds than in closed barns. (See Table 255.) Apparently the heat generated by the digestion and assimilation of heavy grain rations is more than sufficient to keep the animals warm. Although breeding cows and stocker steers on little more than maintenance rations undoubtedly are more sensitive to extremely low temperatures, it is not likely that there is any great advantage in housing them in closed barns.

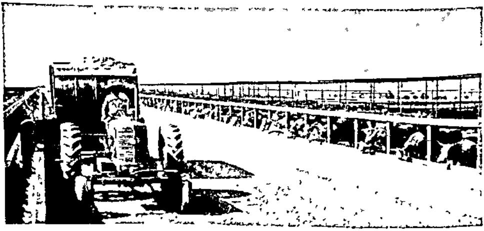


FIG. 96. One man with self-unloading wagon can feed thousands of cattle daily, especially when the ration is fed in complete form—that is, roughage and concentrate mixed in the desired proportions. (National Cottonseed Products Association, Inc.)

Table 255

IMPORTANCE OF SHELTER FOR FULL-FED STEERS

Kind of Shelter	Missouri Circular* (unnumbered)			Pennsylvania Bull. 83†	
	Barn (lb.)	Open Shed (lb.)	Open Lot (lb.)	Barn (lb.)	Open Shed (lb.)
Daily gain per head	1.78	1.99	2.05	1.93	1.95
Grain per lb. gain	11.02	10.37	10.22	9.49	9.51
Dry roughage per lb. gain	4.32	3.74	4.22	6.16	6.04
Digestible matter per lb. gain	10.77	10.25	10.22	....	....
Daily ration					
Shelled corn	21.47	22.83	23.11	....	....
Dry roughage	8.42	8.24	9.55		

* Average of three trials.
† Average of five trials.

Paved Feed Lots. Muddy feed lots impose a severe handicap on winter-fed steers. Many a man has ordered a truck and shipped his half-fat steers to market for no other reason than to get them out of muddy lots in which they were standing up to their knees. Others have permanently abandoned late winter and spring feeding, thereby acknowledging their defeat in the annual battle against slush and mud.

In the early days of cattle feeding, large amounts of corn fodder were fed, the refuse of which formed a thick covering around the feed bunks, sufficiently deep to bear the weight of the cattle. In former years it was also the custom to feed in large lots or on pastures. With such large areas available it was usually possible to avoid excessive mud by feeding first in one place and then in another. The feeder of today, however, has no such relief. His corn stalks are made into silage and are wholly consumed by the cattle or they are left in the field, and the high price of land compels him to use no larger a lot than necessary for dry-lot feeding.

The best insurance so far devised against possible loss in cattle feeding from bad weather conditions is the paved feed lot. The four advantages of pavement may be stated briefly as follows:

1. It adds greatly to the comfort of the cattle, thereby promoting greater and more efficient gains.
2. It reduces the labor involved in feeding.

3. It makes possible the saving of more manure.
4. It results in a larger production of pork from the droppings of the cattle.

The open lot used by feeder steers need not be large. No greater area is required than that which permits the cattle to move about freely without unduly disturbing each other. Forty-five square feet of floor space per mature animal, 35 for yearlings, and 25 for calves is sufficient, especially if the lot adjoins an open shed affording an equal area per head. Two to three thousand square feet of pavement, one-half of which is roofed, furnish ideal conditions for a carload of cattle. The cost of a 5-inch concrete pavement is not excessive and soon pays for itself in the increased pork and manure credits secured, to say nothing of the greater gains made by the cattle or the labor saved in feeding. Asphalt pavings are a questionable investment, especially in the extreme northern and southern states, owing to the problems of freezing and softening, respectively, that are encountered in these regions. By all means, a 6- to 12-foot concrete ramp should be provided for single-sided bunks such as those used in fence

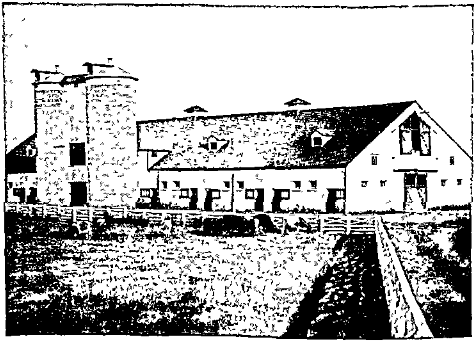


FIG. 97. An elaborate barn designed for housing a purebred herd. Although having some merit from the standpoint of convenience and advertising value, buildings and equipment of this type are by no means essential for success with beef cattle.

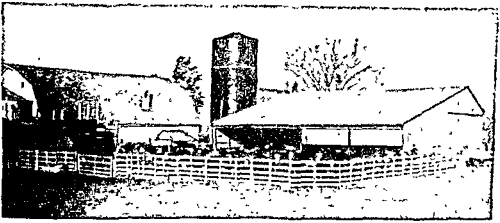


FIG. 98. An example of an inexpensive pole-type cattle shed with bedding or hay storage in back, a compact adjacent concrete paved lot, a nearby, large-capacity bunker silo, and air-tight high-moisture corn storage (Harvestore) combined into an efficient cattle-feeding plant. (University of Illinois.)

lines, and twice that width for double-sided bunks. Equally essential is a 6-foot ramp around the water tank. Reducing the feedlot concrete to these areas makes cleaning the feed lot more inconvenient, but the comfort of the cattle must come first so far as paving is concerned.

Feed Bunks. Portable feed bunks used by beef cattle should be made of 2-inch material, preferably undressed cypress. The legs should be cut from 4- by 4-inch material and should be both bolted and braced to the body of the bunk. A good method of bracing the legs is shown in Figure 99. Bunks that are to be placed in the open,

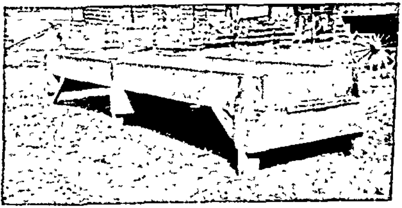


FIG. 99. A good portable-type feed bunk. Its width and depth make it suitable for grain and silage but not very well suited for hay. (University of Illinois.)

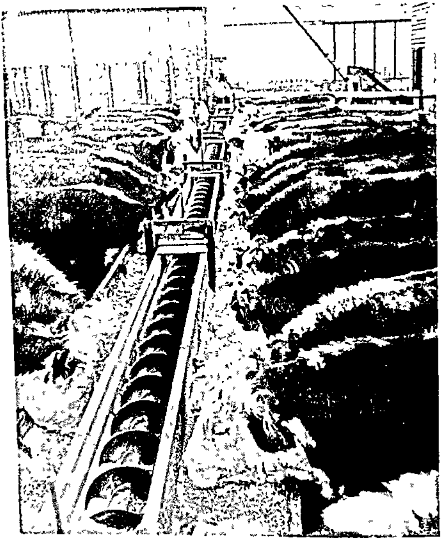


FIG. 100. Auger bunks which deliver both roughages and concentrates to cattle at very low power costs are genuine labor savers. Another type of auger bunk in which the auger is enclosed in a tube with openings at frequent intervals permits the separate feeding of each component of the ration. (University of Illinois.)

where the cattle can eat from both sides, should be at least 30 inches wide. Thirty-six inches is a more satisfactory width for mature cattle. The floor of the bunk should be 20 inches from the ground and should carry 6- to 10-inch sides, depending on the age of the cattle. Feed troughs that are built inside a barn or shed should be made adjustable as to height, to accommodate cattle of various ages. It is also necessary to raise the troughs from time to time if the manure and bedding are allowed to accumulate in the shed.

The development of the self-unloading wagon has been closely followed by a great increase in the use of fence-line bunks. Other

than the labor saved, some advantages of this type of bunk, if used with self-unloading equipment, are shorter travel routes, easier cleaning of lots, and less damage to bunks. However, just twice as many linear feet of bunk space must be provided if such single-sided feeders are used.

Bunk space of 20 to 24 inches per head should be provided if all cattle are to eat at one time. This space may be reduced if cattle are fed two or more times daily or if bunk self-feeding is practiced. Paved, graveled, or rocked driveways are an integral part of the fence-line bunk-feeding system.

Self-Feeders. Figure 95 illustrates a good type of self-feeder which is satisfactory for feeding either ground or shelled corn. A self-feeder 8 feet long, with feed troughs along both sides, holds sufficient feed to last a carload of cattle approximately two weeks.

Hay Racks. Various types of racks and mangers are used for the feeding of hay and other roughages. Figures 101 and 102 are examples of racks suitable for the West and Corn Belt, respectively. Racks such as are shown in Figure 102 are in wide use but are open to the objections that the wastage of hay is considerable and that they are hard to clean out. In general, low mangers such as the one shown in Figure 103 are superior to overhead racks since they necessitate the cattle's working down over the top of the hay in such a

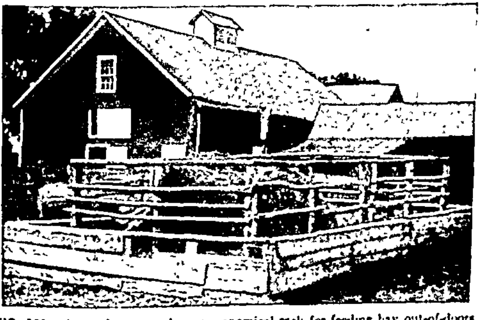


FIG. 101. A satisfactory and very economical rack for feeding hay out-of-doors in the more arid western regions. Such racks are easily filled and cleaned out and wastage is small. (Colorado Experiment Station.)

FIG. 102. Wastage of hay is great in racks of this type. They are unhandy to fill and clean out, and are exposed to the weather.

way as to cause little wastage of the finer particles and chaff. Low mangers have the additional advantage of being satisfactory for the feeding of corn or sorghum stover and other coarse roughages.

Corrals and Restraint Equipment. A good set of corrals with such accessories as a good unloading and loading chute, a squeeze chute with headgate, dipping vat in areas where needed, scales and

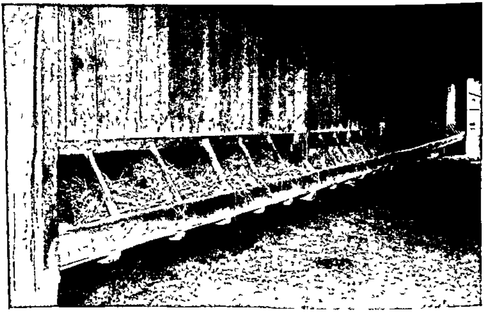


FIG. 103. An excellent hay bunk for a barn with overhead hay storage. Either chopped or long hay can be self-fed directly from the mow. If hay is being limited, daily feeding will be required. (Sam Larimore, Tuscola, Illinois.)

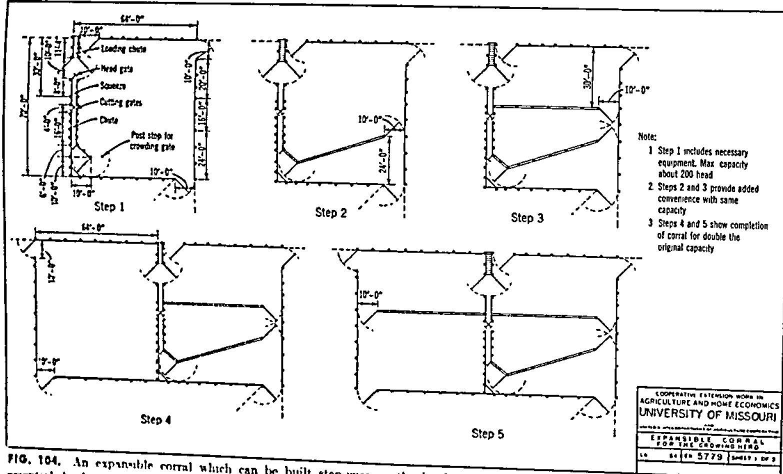
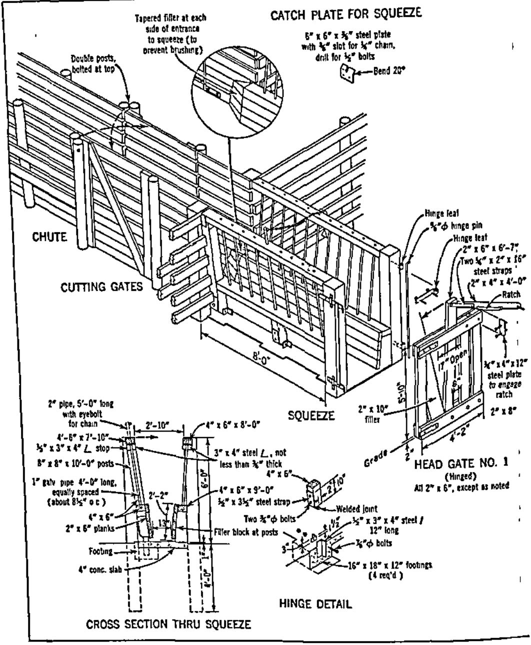
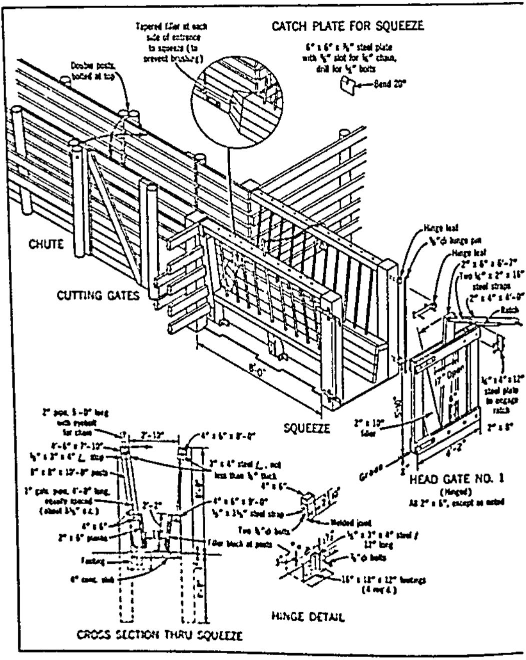


FIG. 104. An expansible corral which can be built step-wise as the herd grows in size up to 200 head. Step 1 includes the essential loading chute, headgate, squeeze and chute. Steps 2 and 3 provide added convenience with the same capacity. Steps 4 and 5 show completion of the corral, doubling the original capacity (University of Missouri and U.S.D.A. Cooperating.)



holding pens with sorting gate, are important tools of the beef cattle man. The size of the operation, of course, determines the most economical size of such equipment. Plans are available from the U.S.D.A. and the various agricultural experiment stations for almost any type and size of layout needed. Figure 104 is one example of a plan for an expanding operation. Note that the simplest plan still


CATCH PLATE FOR SQUEEZE
Tapered filler at each side of entrance to squeeze (to prevent bruising)
Double posts, bolted at top
Bend 20°
CHUTE
CUTTING GATES
8'-0"
SQUEEZE
Hinge leaf
Hinge leaf
Latch
17" Open
2" x 10" filler
2" x 8"
Grade
4'-2"
HEAD GATE NO. 1
(Hinged)
All 2" x 6", except as noted
4" x 6"
2" x 6" posts
Footing
Welded joint
Filler block at posts
HINGE DETAIL
CROSS SECTION THRU SQUEEZE

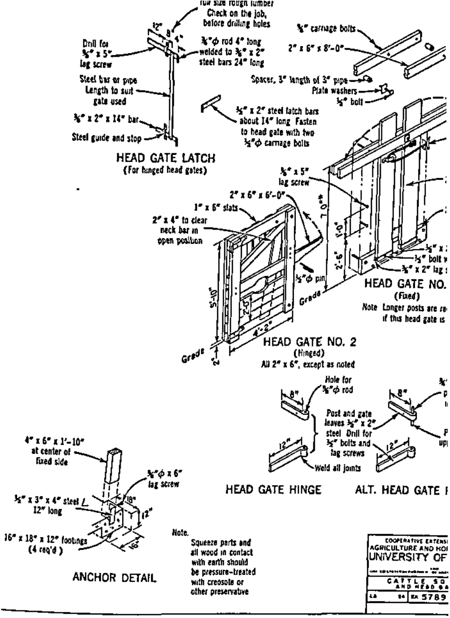


FIG. 105. Squeeze chute with details and three types of headgates (U of Missouri and U.S.D.A. Cooperating.)

contains the squeeze, headgate, and loading chute. Figure 105 several types of headgates, some of which are hinged for a opening chute, and others which are stationary for a side-o chute. All such devices should combine ease of operation

strength of construction, inasmuch as it frequently is necessary, in confining an animal, to close and fasten a gate in the fraction of a minute.

Cattle Stocks. Cattle stocks, or bull stocks as they are often called, are essentially an item of equipment for the purebred herd. Whereas their important features may be so combined with those of an ordinary dehorning chute as to make them useful with unbroken cattle, the more common practice is to build them as a separate or detached unit into which cattle must be led rather than driven. This fact alone would limit their use to animals that are rather easily handled.

The characteristic features of cattle stocks are: (1) rollers on either side at a height of about 4 feet above the floor, made of 5-inch cedar posts or 4-inch steel pipe, for supporting a canvas sling that is placed under the animal to prevent it from lying down while in the stocks; and (2) wooden sills, 6 by 8 inches, that extend along either side at a height of 15 inches from the floor, on which the feet may be rested and tied while undergoing treatment. Cattle stocks are exceedingly useful for the restraint of animals during the performance of such minor operations as the ringing of bulls, clipping of heads, surgical treatment of lump jaw, and trimming of feet. Figure 106 shows an animal secured in the stocks with a foot in position for trimming. The adjustment of the canvas surcingle is such that a

FIG. 106. Cattle stock showing bull in proper position for trimming the right front foot. *The canvas sling under the body supports the weight of the animal and prevents injury.* (University of Illinois.)

part of the weight of the body is taken off the legs, making it almost impossible for the animal to throw itself or lie down.

Breeding Crates. As stated in Chapter 6, breeding crates are useful in safeguarding the breeding of young heifers to old, heavy bulls. A satisfactory type of breeding crate is shown in Figure 107. The back portion of each side of the stall is surmounted by a 2- by 12-inch plank, across the face of which are nailed cleats to prevent the front feet of the bull from slipping. The gate or stanchion labeled *A* in the diagram is adjustable to accommodate cows varying in height and length of body.

Dipping Vats. Dipping vats are useful in ridding cattle of lice and other parasites and diseases that affect the skin. They are most common in the South but are sometimes found in the Corn Belt and the West in connection with extensive feeding plants where large numbers of cattle are handled. Inasmuch as the erection of a modern dipping vat entails considerable expense, one might very properly be built as a community enterprise to serve an entire school district or township. This plan was commonly followed in the South when dipping to eradicate the Texas fever tick was for many years compulsory. Power sprayers have largely supplanted dipping vats for the control of lice and flies. On many farms the same sprayer is used for spraying cattle, disinfecting buildings, spraying the farm orchard, and killing obnoxious weeds.

Loading Chutes. A well-designed loading chute is a necessary item of equipment on every beef cattle farm. Stationary chutes should be located in reference to both roads and holding pens in order that they be accessible to heavy trucks and in order that cattle may

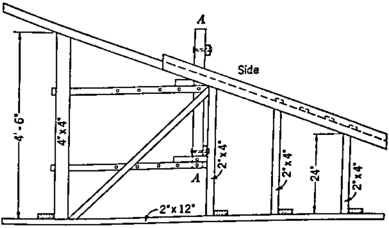


FIG. 107. Diagram of a breeding stock, showing details of construction. (University of Illinois.)

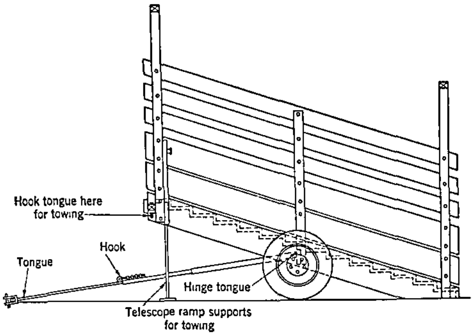


FIG. 108. A portable step-ramp loading chute developed by the Union Stock Yards and Transit Company. (Livestock Conservation, Inc., Chicago, Illinois)

be quickly loaded and unloaded after the truck has been set. Tests carried out at the Union Stock Yards in Chicago indicate that livestock prefer low stair-step risers to a cleated ramp. Whether the advantages of such a chute are sufficient to justify the extra materials and labor required may well be questioned by the farmer who handles only a car or two of cattle a year.

A portable loading chute which may be towed behind a truck is often useful in loading or unloading cattle at a distance from the farmstead where the stationary chute is built. A sketch of a portable truck with a stair-step ramp is shown in Figure 108.

Labor-Saving Equipment. The shortage of labor on livestock farms has caused a wide interest in labor-saving devices which shorten the time and lighten the labor required to care for the animals. Such equipment consists of (1) blowers and conveyors for moving feed, (2) storage of feed and stabling arrangements for animals that require as little movement of the feed as possible, and (3) equipment for cleaning the sheds and yards First class equipment is fairly expensive and consequently is better suited for the large feeder who handles 100 or more cattle than for the farmer who feeds only a carload. On the other hand, the small feeder is usually able to store his feeds nearer the cattle than the large operator can. Often by remodeling his barns and carefully planning the location of his grain

FIG. 109. Mechanical feed-mixing equipment and self-unloading wagons make it possible to increase volume of business without added labor. (University of Illinois.)

bins and silo, the small feeder is able to feed and care for his cattle entirely under cover and with a minimum of hand labor.

Cleaning cattle sheds and lots and hauling and spreading the manure have always been regarded as among the hardest and most disagreeable jobs on the farm. In all probability they have caused many good farm boys to become grain farmers or even leave the farm entirely instead of following in the steps of their cattle-feeding fathers. However, the presence of tractors with hydraulic manure loaders on nearly every farm has now eliminated most of the hand labor formerly required in cleaning sheds and feed yards on livestock farms.

chapter 28 THE MARKETING OF CATTLE

Seldom does a rancher, farmer, or cattle feeder with cattle to sell experience any difficulty in disposing of them at a price near their actual cash value. The matter of selling or buying stockers or feeders has been discussed in Chapter 11; therefore the discussion in this chapter will be confined largely to the marketing of slaughter cattle.

In most areas with a relatively dense livestock population, most if not all of the following avenues are available for disposal of slaughter cattle:

1. Consignment to central or public terminal livestock market.
2. Use of local cooperative shipping association.
3. Consignment to local auction sale.
4. Direct on-the-farm or feedlot sale to packer buyers.
5. Sale of cattle direct to packer buyers at concentration yards or at the packing plant
6. Consignment of cattle to a packer on a carcass dressed weight and grade basis.
7. On-the-farm sale to cattle dealers or local butchers.

The choice of the most suitable market is not a simple one, and rules for making such a choice are nonexistent. The factors which should play the most important roles in making this choice are: (1) current market price per hundredweight, (2) transportation costs, (3) selling expenses, (4) shrinkage, (5) services rendered by the market or its marketing agencies, (6) weighing conditions.

Still other factors which, however, enter into the choice of a cattle market are convenience, custom, and prejudice. Many cattlemen still prefer to deal directly with a buyer because of a feeling that less risk is involved. On the whole, all of the market channels listed previously offer a good market for cattle, but each man with slaughter cattle to sell owes it to himself to make comparative studies of the various markets for the particular cattle he has to sell. The market

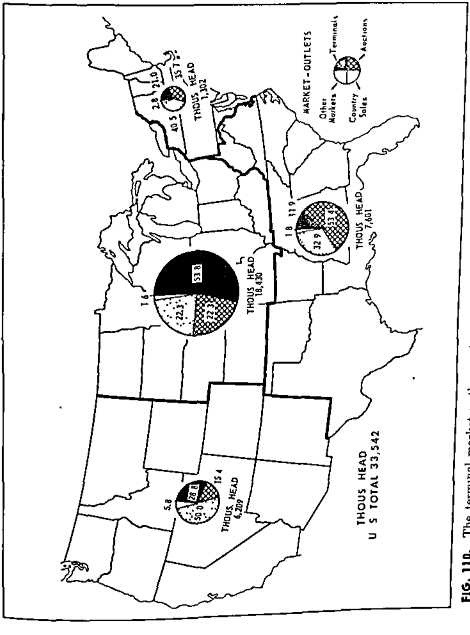


FIG. 110. The terminal market is the most important method of selling in the Corn Belt, whereas direct selling and auction selling are most important in the West and South, respectively (U S D A)

of choice varies tremendously depending upon locality, as is shown by Figure 110. Regardless of which method of selling the cattle feeder chooses, a majority of slaughter cattle eventually are sold to packers in the large central markets.

When to Market. Various rules for marketing have been stated by successful feeders, but it is doubtful that they are taken very seriously, even by their originators. Perhaps the one most frequently heard is, "Ship when the cattle are ready, regardless of the condition of the market." However, it would seem from the appearance of many animals received at the yards that a rule more frequently followed is, "Ship when the market seems right, regardless of the condition of the cattle." Neither rule is a good one if blindly followed, although each expresses an element of truth which should not be overlooked if satisfactory returns are to be realized.

The approximate time of marketing should be decided at the time the cattle are placed on feed. Only by knowing the length of the feeding period in advance can the method of feeding be planned intelligently. As the cattle begin to approach the degree of finish desired, the market should be studied in an effort to obtain as favorable a price as possible. However, there is no way of knowing definitely which way the market will go. Even the commission men and large buyers, who have had long years of experience, occasionally make serious errors in predicting future price tendencies. Nevertheless, the judgment of such men deserves respect, and their advice regarding shipping should be given careful consideration. They have at hand much information regarding total supplies, expected loadings, religious holidays affecting consumption, and conditions of the dressed beef trade, that is not available to the individual shipper.

Generally speaking, the relative prices being paid for a particular weight and grade of cattle are determined by the total supply of such cattle on the major markets in the country. This is well illustrated by Figure 111 One of the leading livestock journals has prepared a calendar for marketing beef cattle, based on average prices generally received at the major markets. (See Figure 112.)

Preparing Cattle for Shipment. Considerable difference of opinion exists regarding the advisability of attempting to reduce shrinkage by changing the ration before shipping. Some feeders remove all laxative feeds such as protein concentrates and legume hay or silage a day or two before shipment and supply non-laxative feeds instead Others withhold both feed and water on the day of shipment in the belief that the cattle fill better at the market if they arrive hungry and thirsty Occasionally an unscrupulous shipper

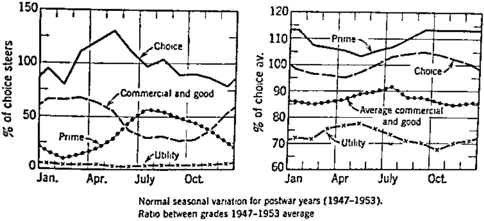


FIG. 111. Receipts and relative prices by grades of beef steers sold at Chicago, 1947–1953 (U.S.D A.)

salts his cattle heavily on the day of shipment to obtain a heavier consumption of water at the market. However, seldom is anything gained from abnormally large "fills," since buyers quickly detect such cattle and refuse to bid on them until late in the day, when the excessive weight has largely disappeared.

Unfortunately, little information is available regarding the control of shrinkage in cattle. Yet it is an extremely important subject, particularly when cattle prices are high. When cattle are worth \$30 per hundredweight the 40 pounds lost during transit amount to \$12 a steer. Anything the shipper can do to reduce the loss by 5 to 10 pounds per head without noticeably impairing the slaughter value of the cattle is highly profitable.

Preliminary studies made at the Illinois station indicate that withholding feed and water on the day of shipment increases rather than reduces shrinkage. (See Table 256.) Apparently cattle thus handled are greatly disturbed by the abrupt change in their feeding schedule and spend the day on their feet vainly waiting for feed and water instead of lying quietly at rest. As a result they are tired and nervous when loaded and arrive at market in a fatigued condition. Though shrinkage based on loading weights may be in their favor, the cattle actually have lost considerable weight before they were loaded. This loss may well be 20 to 30 pounds, or the weight of the feed and water that would have been consumed if the regular schedule of feeding had been followed.

Other studies made at the Illinois station indicate that the substitution of oats for part of the shelled corn ration, and timothy or mixed hay for alfalfa or clover hay, is a sound practice, inasmuch

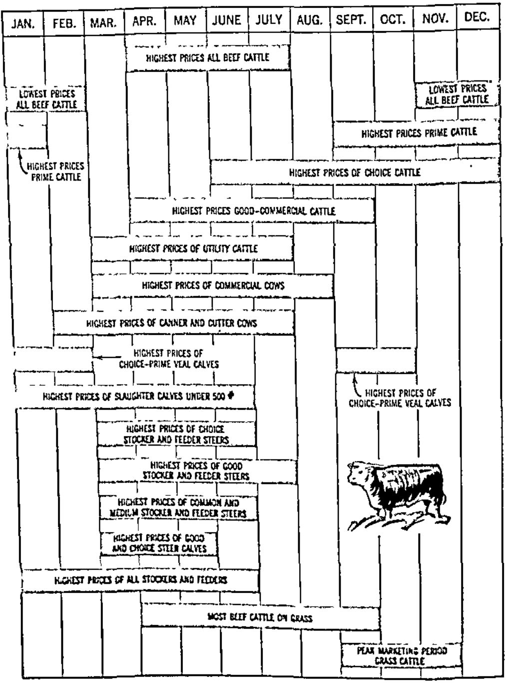


FIG. 112. A calendar for marketing beef cattle. Each weight and grade of slaughter cattle has its period of high and low prices during the year. There are indications that these seasonal fluctuations are narrowing, undoubtedly owing to year-round feed yard operations. (National Livestock Producer.)

Table 256

EFFECT OF CHANGING FEED UPON SHRINKAGE OF FAT CATTLE DURING SHIPMENT*

	Withholding Feed and Water on Day of Shipment		Replacing Laxative Feeds			
			Heifer Calves		Yearling Steers	
	Fed as Usual	Feed and Water Withheld	Shelled Corn, Clover Hay	Sh Corn 50%, Oats 50%, Timothy Hay	Shelled Corn, L S M, Clover Hay	Sh Corn 50%, Oats 50%, Timothy Hay
Weight out of experiment ..	999	998	649	649	1070	1095
Length of change period ..	10 hr.	10 hr	6 days	6 days	4 days	4 days
Shipping weight...	999	982	666	665	1069	1104
Market weight.	963	952	616	624	1011	1052 5
Shrinkage, lb.						
On final experiment weight	36	46	33	25	59	42 5
On shipping weights.	36	30	50	41	58	51 5
Shrinkage, percentage						
On final experiment weights	3 6	4 6	5 1	3 9	5 5	3 9
On shipping weights .	3 6	3 1	7 5	6 2	5 4	4 7
Dressing percentage	60 6	59 6	57 9	56 0	59 7	58.1

* Illinois Mimeo. Report, 1951.

as these changes resulted in less shrinkage. (See Table 256) However, these non-laxative feeds should be introduced into the ration 4 or 5 days before shipment in order that the undigested portions may have time to affect the nature of the content of the large bowel.

Rail vs. Truck Shipment. Before the advent of the motor truck, cattle were almost always driven from the feed lot to the loading point, but now they are usually hauled. Trucks have replaced rail transportation to a large extent within 200 miles from the central markets, and some of the large trailer trucks operate over even longer distances.

The comparative merit of rail and truck transportation for fed cattle is a disputed point. Cattle undoubtedly ride more comfortably and safely on the rails than they do in the average truck. However, the greater convenience afforded by the truck in loading the cattle at the farm, at the hour most agreeable to the owner, the somewhat lower charge, and the greatly reduced time during which the cattle are en route have made the truck the favorite method of most feeders

Table 257

RELATIVE USE MADE OF RAILROADS AND TRUCKS IN TRANSPORTING CATTLE TO MARKET

Market	Per Cent of Cattle Received by Truck 1935*	1949†	1957
Chicago	35.3	78.9	86.1
East St. Louis	46.9	72.6	
Indianapolis	84.0	92.0	
Kansas City	32.4	50.6	
Omaha	54.2	78.9	
Peoria, Ill.	86.9	86.7	
Sioux City	72.9	78.0	
South St. Paul	49.9	73.0	
62 public markets	51.0	71.7	

* U.S.D.A., Livestock and Wool Statistics and Related Data, June, 1936.
† U.S.D.A., Livestock Market News, August, 1950.

who are within easy trucking distance of the market. Since the presence of automobiles on main highways and the poor condition of fences along secondary roads make the driving of cattle to the railhead impractical in most communities, they must be transported by truck from the farm to the loading point, even though they are

Table 258

COMPARISON OF TRUCK AND RAIL SHIPMENT OF FED STEERS

	Colorado Bulletin 422 (3-Year Average) Truck	Rail	Illinois Unpublished Data (Average of 3 Shipments) Truck	Rail
Number of cattle	100	100	69*	70*
Shipping weight, lb.	835	833	1,041	1,052
Market weight	806	805	1,009	1,009
Shrinkage	29	28	35	43
Shrinkage (percentage)	3.6	3.4	3.4	4.1
Bruised carcasses	5.5	4.0	10†	10†
Freight rate	0.17	0.16	25	22
Hours in transit	3.17	7.0	7.1†	13.0†
Distance shipped, miles	70	70	135	135

* Total cattle in three shipments.
† Average of two shipments.

shipped to market by rail. Usually when they are once in the truck they can be taken directly to market in much less time and at little more expense than would be incurred if they were trucked only to the local station and reshipped by rail. (See Table 258.)

Cattle per Car. The standard stock car is 8 feet 6 inches wide and either 36 or 40 feet long. The shorter car is billed with a minimum weight of 22,000 pounds, and the longer one with 24,400 pounds. That is, the shipper must pay freight on this weight whether his load weighs that much or not. In computing freight charges, market weights are taken, less 800 pounds deducted for "fill." No maximum weights are specified, and the shipper may crowd as many cattle into the car as he can. As an average, about 22 two-year-old slaughter steers or 28 yearlings constitute a load for a 40-foot car. Cattle ship better if the car is comfortably filled, although overcrowding is more objectionable than underloading. If fewer than 15 mature cattle are to be shipped they should be partitioned off in one end of the car and the remainder of the space used for some other class of livestock. Such a plan results in a saving in freight and the cattle are not jolted about so severely by the sudden starting and stopping of the train.

Billing. Cattle shipped to market should be billed to a reliable commission firm, of which there are 50 or more at large markets such as Omaha, Kansas City, and Chicago. It is not necessary to inform the firm in advance of the shipment, although it is good business practice to do so. Neither is it necessary for the shipper to accompany the cattle to market. In all probability they will sell for just as much whether he is present or not. It is, however, highly instructive for him to be at the market to compare his cattle with others that sell for higher and lower prices. In this way he will be better able to estimate the probable market value of cattle which he handles in the future.

If the distance from market or unfavorable weather conditions make it at all likely that the cattle will be en route more than 28 hours when shipped by rail, a so-called "release" should be signed by the shipper at the time the car is billed. Otherwise the cattle must be unloaded at the end of 28 hours to be fed, watered, and rested. When a release accompanies the waybill, unloading need not take place until the elapse of 36 hours.

Shrinkage. Shrinkage refers to the loss in weight between feed lot and market scales. It may be expressed either in pounds per head or in percentage of the weight before shipment. The percentage method is to be preferred, inasmuch as the amount of weight lost usually bears a direct ratio to the size of the cattle.

Table 259

AVERAGE CAPACITY OF RAIL CARS AND STOCK TRUCKS FOR TRANSPORTING CATTLE AND CALVES

	Rail Cars*		Stock Trucks†				
Length	36′	40′	10′	12′	14′	18′	30′
Calves							
350 lb.	55	62	12	15	18	24	42
450 lb.	46	51	10	13	15	20	34
Cattle							
600 lb.	36	40	8	10	12	16	27
800 lb.	30	33	7	8	10	13	22
1000 lb.	26	28	6	7	8	11	19
1200 lb.	22	24	5	6	7	9	16
1400 lb.	19	21	4	5	6	8	14

* Western Weighing and Inspection Bureau, Chicago, Illinois.
† International Harvester Co.

Shrinkage during shipment is largely due to excretions from the alimentary tract and the urinary organs, and to a lesser degree, to tissue moisture given off by the lungs in breathing. A portion of this loss is regained at the market from the feed and water consumed between the time of arrival and the time the cattle are sold and weighed. The amount of shrinkage expressed in percentage of the home or loading weight varies considerably between different loads of cattle The principal factors responsible for this wide variation are:

THE LENGTH OF THE JOURNEY. The longer the journey, the greater the shrinkage. The loss in weight, however, does not bear a direct ratio to the distance traveled, since the greatest loss occurs during the first few miles, often between the feed lot and the loading point. (See Table 260)

THE DEGREE OF COMFORT EXPERIENCED EN ROUTE. During extremely hot or very cold weather, shrinkage runs unusually high. Badly crowded cars or trucks and slow, rough runs on trains that make frequent stops are certain to result in considerable loss in weight.

THE CONDITION OF THE CATTLE AT THE TIME OF LOADING. As far as possible, the condition of the cattle should be normal at the time they are loaded. Tired, hungry, or thirsty animals are in poor physical condition to stand the trip, and are slow to recover upon reaching the market. Likewise, cattle that have consumed large quantities of green grass or have taken too great a fill of water just previous to loading are in poor condition for the journey.

THE KIND OF FEEDS USED. Cattle that have been fed large quanti-

ties of roughage, such as grass and silage, commonly lose more weight than those that have received a full feed of grain. Also cattle that have been fed laxative feeds such as soybean oil meal and alfalfa hay suffer a larger shrinkage than cattle fed feeds of a less laxative nature. Contrary to the belief of many, silage-fed cattle do not shrink as much as cattle fed dry roughages. (See Table 261.)

THE CONDITION OF THE CATTLE. Since shrinkage is principally due to the loss of excrement from the bladder and bowels, it bears a much closer relation to the size of the animal than to its degree of finish. In other words, thin 2-year-old steers lose about as much weight per head during shipment as fat 2-year-olds that are 200 or 300 pounds heavier. However, the shrinkage per 100 pounds live weight is much higher for the thin cattle. Grass-finished cattle are likely to have a much higher shrink, expressed as a percentage of the loading weight, than grain-fed cattle because they have had a more laxative ration and because they are in lower condition

THE FILL AT MARKET. The consumption of feed and water after arrival at market is the most important factor in determining the net amount of shrinkage suffered. This consumption in turn is influenced by several factors, of which the more important are: (1) weather conditions at the market on the day of sale, (2) the length of time the cattle are in the pens before they are sold and weighed, (3) the condition of the cattle upon arrival.

Smaller fills are obtained during cold, damp weather than on bright, warm days. Cattle drink little at such a time and have little appetite for hay after it becomes wet.

Table 260

EFFECT OF LENGTH OF HAUL UPON THE SHRINKAGE OF GRAIN-FED CATTLE TRANSPORTED BY TRUCKS*

Weight Classes	Number of Head	Average Full Weight Out of Lot	Cumulative Percentage of Shrinkage: After 25 Miles	After 50 Miles	After 100 Miles	After 200 Miles
Under 1000 lb.	11	954	1 5	2 2	3 1	3 0
1000–1099 lb.	10	1056	2 1	3 0	3 8	4 1
1100–1199 lb.	24	1139	1 8	2 6	3 4	4 1
Over 1200 lb.	15	1263	1 9	2 4	3 1	3 6
Group average	60	1122	1 8	2 5	3 3	3 9

* Unnumbered report, Chicago Union Stock Yards and Transit Co. December 1951

Note: The cattle in this study were hauled in groups of 5 head in a truck which had a scales on one end, on which they were weighed individually after covering the respective distances. No opportunity to fill was allowed before weighing. Initial weights taken in morning before the cattle were fed.

Table 261

SHRINKAGE OF CATTLE DURING TRANSIT*

Class of Cattle	Hours in Transit	Number of Shipments	Number of Cattle	Average Weight at Origin (lbs.)	Gross Shrinkage		Fill at Market		Net Shrinkage		
					Range (lbs.)	Average (lbs.)	Range (lbs.)	Average (lbs.)	Range (lbs.)	Average (lbs)	Per cent of Live Weight at Origin
Grain-fed											
Non-silage	Less than 24	4	164	1303	59–95	67	4–48	16	20–64	51	3.91
Non-silage	24–36	59	1853	1167	47–128	85	19–52	37	18–88	48	4.11
Silage-fed	Less than 24	14	666	1168	46–128	76	6–97	52	+7†–67	24	2.05
Silage-fed	24–36	4	169	1204	84–121	101	50–64	58	27–75	43	3.57
Grass-fattened											
Mixed-range	Less than 24	21	1511	700	19–84	37	1–56	22	+12†–71	15	2.14
Mixed-range	24–36	17	872	848	27–118	72	–8‡–55	18	19–114	54	6.37

Average shrinkage of grain-fed cattle in transit less than 36 hours, 3.62%.
Average shrinkage of grass-fattened cattle in transit less than 36 hours, 3.88%

* *U. S. D. A. Bulletin No. 25.*
† Abnormal load, market weight exceeding loading weight.
‡ Abnormal load, sale weight less than unloading weight.

The most satisfactory fills are obtained when the cattle reach the market about daylight, which permits them to be penned and fed at about their usual feeding time. As a rule, the market is not under way until nine o'clock, so that the cattle have at least 2 or 3 hours in which to eat and drink. Cattle that arrive after the market has opened may be in the pen only a few minutes before being sold and are weighed almost empty. Although the price paid for such cattle is often somewhat higher than would have been bid had the cattle taken on the usual fill, the buyer rather than the seller is most likely to profit from the late arrival. After cattle have been in the pens for 4 or 5 hours they cease eating and drinking and begin to lose rather than gain in weight. Consequently, good fills are associated with brisk, active markets, rather than with slow, long-drawn-out trading that runs into the afternoon session.

Cattle that arrive at the market tired and worn out from a long, hard journey, or weakened by insufficient water and feed immediately before or during shipment, frequently lie down upon being unloaded and will not eat or drink to any extent until they have obtained some rest. If sold on the day of their arrival, their shrinkage is much above the average because of their small fill. If given time to recover, or if they are suffering only from hunger and thirst, they will probably take on such a large fill that buyers will have nothing to do with them until the effects of the fill have largely disappeared. Best results are secured when the cattle are only moderately hungry and thirsty when received. In such condition they fill to a moderate extent, but not to the point where they invite unfavorable criticism.

Losses Sustained During Shipment. Losses resulting from the injury or death of cattle while in transit are of infrequent occurrence. Because of their size and strength, cattle are less likely to be injured by the rough handling of cars or trucks than are swine and sheep. They are also much better able to withstand unfavorable weather conditions encountered en route than are the other two classes of meat animals. Probably fully 99 per cent of all cattle shipments arrive at the market with no dead or crippled animals.

Statistics kept by the U.S.D.A. of all dead and crippled livestock received at the public stockyards of the United States show that a much smaller percentage of cattle are injured during shipment than of calves, swine, or sheep. (See Figure 113.) No data are available regarding the relative losses of cattle by truck and by rail. However, the fact that the number of dead hogs arriving by truck at 20 large markets was about 30 per cent larger than those arriving by rail for

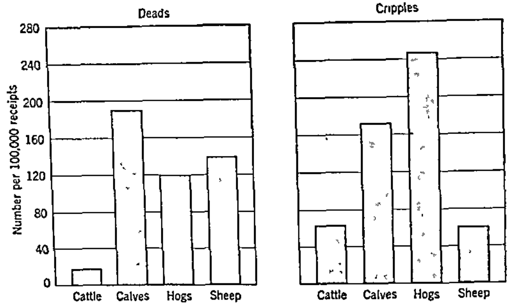


FIG. 113. Number of dead and crippled animals encountered in receipts of the different classes of livestock, as reported by the Bureau of Agricultural Economics for 1950. (Livestock Conservation, Inc., Chicago, Illinois.)

each year from 1946 to 1950, inclusive, indicates that truck losses are probably greater than rail losses for all classes of livestock. These losses are mainly due to carelessness and can to a large extent be prevented by careful loading and handling. This fact is proved by the reduction in the number of dead hogs arriving by truck from 1.48 per 1,000 head during the same period.[1]

Unfortunately the relatively few dead and crippled cattle which arrive at the market are not the most serious losses that occur during shipment and for which shippers must make restitution through lower prices than otherwise would be paid for their cattle. Whereas the 2,860 dead and the 12,875 crippled cattle received at public stockyards during 1950 represented a loss of probably less than $2,000,000, the total loss due to bruises was estimated at $27,500,000.[2] Unfortunately, bruised animals cannot be detected by the buyer at the time of purchase; consequently, he must buy all cattle on the basis that a loss of $1.50 to $2.00 a head will be encountered during slaughter as the result of bruises that must be trimmed out of the carcass beef. (See Figure 114.) This loss represents 15 to 20 cents per 100 pounds live weight, or $30 to $45 a carload.

An individual shipper can avoid losses from dead and crippled cattle

[1] Livestock Conservation, Inc., Annual Report, 1950–1951, p. 7.
[2] *Ibid.*, p. 3.

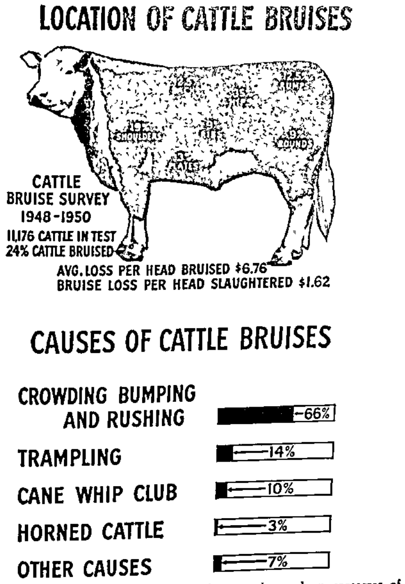


FIG. 114. Location and estimated causes of bruises observed on carcasses of beef cattle during slaughter tests conducted by Wilson and Company (Livestock Conservation, Inc., Chicago, Illinois.)

by careful loading and handling, but he cannot escape the losses resulting from bruising so long as other shippers handle their cattle roughly during shipment. Consequently, every cattle feeder should give his wholehearted support to the program of Livestock Conservation, Inc., an organization representing railroads, commission firms, packers, and stockyard companies, whose principal objective is to reduce losses in marketing livestock.

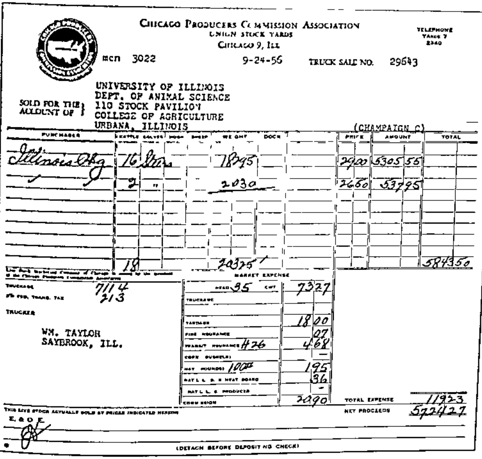
Marketing Costs. A knowledge of the items that make up the total marketing expense is highly desirable to enable the individual feeder to estimate accurately the value of his cattle in the feed lot on the basis of current market quotations. Frequently he is called upon to choose between selling his cattle to a local dealer at a certain price and shipping them to the market on his own account. It is evident that he must know the approximate cost of marketing per hundredweight before he can arrive at an intelligent decision.

Marketing costs are of two kinds, direct and indirect. The direct costs include those cash charges made by the transportation companies and marketing agencies. Indirect costs refer to the loss of weight or shrinkage suffered by the animals between feed lot or shipping point and the market. To the feeder who ships his own cattle, only the direct costs are of interest in computing the cost of marketing per head or per hundredweight. But the man who contemplates selling to a local butcher or dealer must give due consideration to both direct and indirect marketing costs before he is in a position to evaluate his cattle at the loading point on the basis of what they would probably bring at the central market.

Figure 115 shows the account of sale for a truck shipment of steers hauled a distance of 140 miles. Only the direct costs are considered in computing the average marketing expense per steer and per hundredweight shown in Table 262. These costs are made up of the following items:

Freight. Freight constitutes by far the largest item of expense in the marketing of cattle unless, of course, they are sold at home. The freight charges have risen steadily during the last two decades, but additional services sometimes offset some of these increases. The freight charge varies, of course, with the distance traveled and the weight of the load. Generally speaking, freight charges are figured on the sale weight of the cattle, but if only a partial load is hauled the charge may be made on a mileage basis. Although it may appear that freight costs are eliminated by selling at home, the buyer in turn has to pay comparable freight costs; naturally the buyer tries to pay enough less for the cattle to offset these costs.

Commission. Cattle shipped to a central market must be consigned to a livestock commission firm, of which there are 50 to 75 at each of the four or five large markets adjacent to the Corn Belt states. Employees of the firm receive the animals from the stockyards company, drive them to the pens, and see that they have access to plenty of feed and water. When the market opens, a salesman, frequently one of the members of the firm, shows the cattle to pro-



CHICAGO PRODUCERS COMMISSION ASSOCIATION
UNION STOCK YARDS
CHICAGO 9, ILL.
TELEPHONE YARDS 7 2340
MCH 3022 9-24-56 TRUCK SALE NO. 29643

SOLD FOR THE ACCOUNT OF
UNIVERSITY OF ILLINOIS
DEPT. OF ANIMAL SCIENCE
110 STOCK PAVILION
COLLEGE OF AGRICULTURE
URBANA, ILLINOIS (CHAMPAIGN C)

PURCHASER	CATTLE		WEIGHT	PRICE	AMOUNT	TOTAL
Illinois Pkg	16	Strs	17895	29 00	5305 55	
	2	"	2030	26 50	537 95	
	18		20375			5843 50

TRUCKAGE 71 14
3% FED. TRANS. TAX 2 13
TRUCKER
WM. TAYLOR
SAYBROOK, ILL.

MARKET EXPENSE	
HEAD 35 CWT	73 27
TRUCKAGE	
YARDAGE	18 00
FIRE INSURANCE	07
TRANSIT INSURANCE 4 26	4 68
CORN BUSHELS	—
HAY POUNDS 1000	1 95
NAT'L L. & M. MEAT BOARD	36
NAT'L L. S. PRODUCER	—
COMMISSION	20 90

TOTAL EXPENSE 119 23
NET PROCEEDS 5724 27

THIS LIVE STOCK ACTUALLY SOLD AT PRICES INDICATED HEREON
E. & O. E.
(DETACH BEFORE DEPOSITING CHECK)

FIG. 115. Account of sale for a truckload of slaughter steers sold in Chicago

Table 262

MARKETING EXPENSES FOR A TRUCK SHIPMENT OF STEERS
(18 head, hauled 140 miles)

Item of Expense	Cost, Entire Shipment	Cost per Head	Cost per cwt	Per Cent of Total Marketing Cost
Freight	$71.14	$3 95	$0 350	60.0
Commission	20.90	1.16	0 102	17.5
Yardage	18.00	1 00	0.089	15.1
Insurance	4.75	0.26	0.022	3.8
Federal transportation tax	2.13	0.12	0 011	1 7
Feed	1.95	0 11	0.010	1.6
National Livestock and Meat Board	0.36	0.02	0.002	0.3
Total	$119.23	$6 62	$0.586	100.0%

spective buyers and finally sells them, unless otherwise instructed by the owner, for the highest offer he has received.

Immediately after the cattle are sold they are driven to the scales where they are weighed and locked in holding pens to await the orders of the purchaser. The weigh ticket is sent by messenger to the office of the commission firm, where the marketing expenses are computed and a draft is drawn upon the firm's account for the net proceeds of the sale. The draft, together with a statement of the sale, is delivered to the owner, if present, or is mailed to his home address or to his local bank. All settlements for freight, yardage, feed, et cetera, and the collection of the money from the purchaser of the cattle are made by the commission firm without any trouble whatever to the owner.

For all these services a regular charge is made, based upon the number and, on some markets, the weight of cattle sold. The commission for selling varies slightly between different markets and is changed from time to time to meet new business conditions. On January 1, 1958, the selling commission at Chicago was as follows:[3]

Consignments of only one head	$1.50 per head
First 5 head in each consignment	1.20 per head
Next 10 head in each consignment	1.15 per head
Each head over 15 in each consignment	1.10 per head

Considering the multiplicity of details attended to, the value of the product sold, and the amount of responsibility assumed by the salesman individually and the firm collectively, the present commission charges are remarkably low, averaging less than ½ of 1 per cent of the gross value of fed cattle. It is highly doubtful that farmers take home as high a percentage of the sale value of any other major agricultural product as they do in the case of beef cattle.

Commission charges in auction sales are generally based on the gross returns of a sale and average about 3 per cent of the gross returns. At some sales the buyer reserves the right to refuse the highest bid, in which case the cattle are "passed out" with either no charge, or up to 50 per cent of the normal sale charge. In a few instances, commission charges are made on a per head basis, but this inequitable system of making charges is becoming less common.

Yardage. A nominal fee of 75 cents to 1 dollar per head is charged by the stock yards company at the terminal markets for the use of the pens, watering facilities, scales, etc. This is the main source of

[3] Formerly, buying charges for feeder cattle were considerably lower than selling charges, but currently they are the same on most markets.

revenue for the stock yards company and from it must come all money expended for cleaning the pens, repairing fences, pavement, and buildings, as well as for interest, taxes, and dividends. Yardage is paid only once, regardless of the length of time the cattle are held before slaughter or reshipment.

INSURANCE. Transit insurance is required if cattle are hauled by public transportation, and it is generally a worth-while investment. As mentioned earlier, the percentage shipping losses are small; consequently the premium rate is correspondingly low. In addition to transit insurance, at all large markets a charge of 5 to 15 cents per car is made against both shipper and buyer to provide for insurance of the cattle against fire while they are in the yards. In this way a fund is maintained which is adequate to reimburse owners for the full market value of any animals destroyed. The wisdom of providing for such a fund was fully justified in October, 1917, when a fire in the Kansas City Yards destroyed nearly 10,000 head of cattle and calves. Fortunately the insurance fund that had been built up in the preceding years was sufficient to reimburse fully every owner involved. Checks to the amount of $1,733,779.99 were mailed out the day after accredited appraisals had been made.

FEDERAL TRANSPORTATION TAX. All agencies which haul livestock for the public are required to pay a 3 per cent federal transportation tax, based on the transportation charges. Naturally these costs are passed on to the shipper in most instances.

FEED. After being unloaded the cattle are fed hay at the rate of about 10 pounds per head, or 200 pounds per car or truckload. This hay is purchased from the stock yards company at approximately twice the price of hay on the farm. However, this price includes delivery of the hay to the pens and placing it in the mangers before the cattle.

If, for any reason, corn-fed cattle are held overnight before being sold, they are given a feed of shelled corn. Other feeds are usually available if the owner of the cattle wishes to use them.

NATIONAL LIVESTOCK AND MEAT BOARD. A 2-cent per head deduction is made by commission firms in yards which cooperate with this nationwide organization, whose purpose is to promote the consumption of meat and meat products. Such promotion is conducted through all of the various mediums of communication such as demonstrations, television, radio, and newspapers. Meats research is sponsored in universities and private research organizations throughout the country to investigate such subjects as the value of meat protein in the human diet, palatability factors in meat, and so forth. The deductions are

voluntary and are generally matched with an equal amount by the slaughter plant which is buying the cattle.

The total marketing costs per hundredweight, exclusive of freight and shrink, amounted to only approximately 25 cents in the example illustrated by Table 262. It is doubtful if so much selling and service can be obtained for so little cost in any other area of agricultural production It seems reasonable to assume that the buyer who buys directly on the farm or in the feed lot pays enough below central market price to take care of the freight and shrink costs, and it is also a reasonable assumption that an experienced buyer does a closer job of estimating shrinkage than the feeder does.

Effect of Shrinkage on Marketing Costs. The loss in weight suffered by cattle between the farm and market is as important a factor in determining their home value per hundredweight as the actual marketing charges that must be paid in cash. The monetary loss suffered from shrinkage depends upon two factors, namely, the amount of weight actually lost and the value per hundredweight of the cattle. Both of these items may vary considerably between different shipments. Because of these variations it is impossible to name a figure that represents, with any degree of accuracy, the "margin" a local dealer must have in order to "break even." With steers shrinking 3 per cent during transit and selling for $30 at the market, a shipping margin of 90 cents per hundredweight would be necessary to cover the loss due to shrinkage. But with cows shrinking 4 per cent and selling for only $15 per hundredweight, a margin of only 60 cents would suffice. To this margin must be added the approximate fixed charges per hundredweight to obtain the total difference that should exist between feedlot and market values. This difference lies between $1 and $2 per hundredweight for most of the cattle in the Corn Belt.

chapter **29**

DISEASES OF BEEF CATTLE

The incidence of disease in beef cattle is low in comparison with the disease rate of the other important species of livestock. Nevertheless, losses do occur and may be of considerable importance in individual herds. The total monetary loss due to deaths amounted to an estimated $669,000,000 annually in a recent survey, and reduced production resulting from disease ran into an even larger figure. The beef cattle industry can ill afford such losses.

Data relative to the degree of incidence of specific diseases in beef cattle are limited and subject to errors in diagnosis on the part of the farmer, rancher, or veterinarian. A recent and rather comprehensive survey dealing with most of the problems encountered in the beef cattle business, including diseases and parasites, was conducted by the Washington Experiment Station in cooperation with the Research Committee of the American National Cattlemen's Association. Unfortunately much of the Corn Belt area, the northeastern, and the upper southeastern states are not included in the survey. However, the 1,588 questionnaires, representing 502,616 head of cattle, supply information which rather adequately serves as a basis for discussing the incidence of disease among beef cattle

Table 263 summarizes the data from these questionnaires concerning incidence of the various non-nutritional diseases encountered. Figure 116 shows the five most important non-nutritional diseases, by areas surveyed. It will be noted that, with few exceptions, the same diseases are of importance throughout the country, and it is doubtful if the results of the above survey would have been much different had the entire country been surveyed. An annual mortality rate of 0.59 per cent due to non-nutritional diseases and ailments was reported, with 60 per cent of all death losses being caused by pneumonia, calf scours, shipping fever, and blackleg, listed in order of importance.

Incidence of ailments of a non-infectious nature and nutritional

Table 263

INCIDENCE OF BEEF CATTLE NON-NUTRITIONAL DISEASES AND AILMENTS*

Disease	Herd Incidence of Disease (cattlemen reporting disease)† (%)	Incidence of Disease (% of total cattle afflicted by disease) (%)	Herds Reporting the Disease in Which the Veterinarian: Diagnosed the Disease (%)	Treated the Disease (%)
Pink eye	46.2	3.07	3.0	2.1
Calf scours	30.8	1.09	3.9	2.5
Shipping fever	11.7	0.84	2.5	2.2
Foot rot	28.3	0.74	4.8	3.8
Pneumonia	23.2	0.46	7.5	6.0
Warts	21.3	0.33	2.0	1.6
Cancer eye	36.8	0.32	7.2	8.6
Lumpy jaw and wooden tongue	25.4	0.22	5.5	6.2
Brucellosis	8.8	0.18	4.2	2.8
Leptospirosis	0.9	0.17	0.6	0.4
Calf diphtheria	8.1	0.13	3.8	2.8
Sunburned udder	3.5	0.11	0.0	0.0
Prolapse of uterus	13.0	0.10	4.0	4.9
Navel infection	7.4	0.09	1.0	1.1
Blackleg	10.2	0.04	2.6	2.1
Vaginitis	1.8	0.03	0.8	0.8
Brisket disease	0.4	0.01	0.0	0.0
Mucosal disease	0.7	0.01	0.3	0.3
Red water disease	1.3	0.01	0.4	0.4
Tetanus	0.7	0.01	0.3	0.3
Circling disease	0.5	0.00	0.2	0.3
Mastitis	0.4	0.00	0.2	0.2
Retained placenta	0.1	0.00	0.0	0.0
Anthrax	1.1	0.00	0.3	0.3
Pulmonary emphysema (Grunting disease)‡	0.06	0.00	0.0	0.0
Rabies	0.3	0.00	0.1	0.1
Vibriosis	0.06	0.00	0.1	0.1
Hardware disease	0.6	0.00	0.1	0.1
Johne's disease	0.2	0.00	0.1	0.2
Diseases not diagnosed	6.7	0.05	0.1	0.1
Other diseases	3.2	0.02	1.4	1.2
Total		8.03		

* Washington Experiment Station Bulletin 562, 1955.

† This column will total over 100% because many cattlemen reported having several diseases in their herds.

‡ This may be a nutritional disease or ailment but proof on this point is lacking.

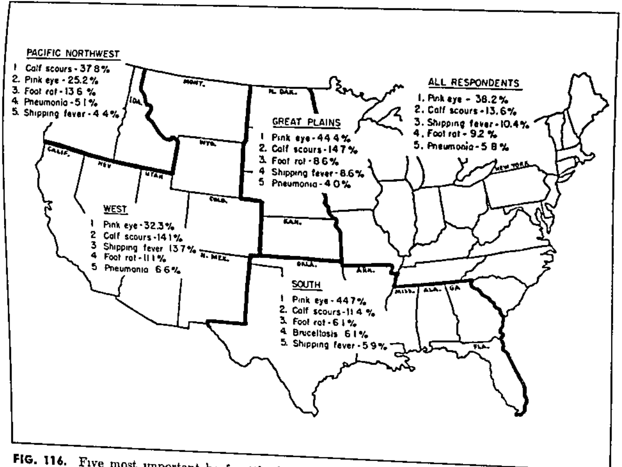


FIG. 116. Five most important beef cattle diseases and ailments (non-nutritional) by areas in the United States. (Washington Experiment Station)

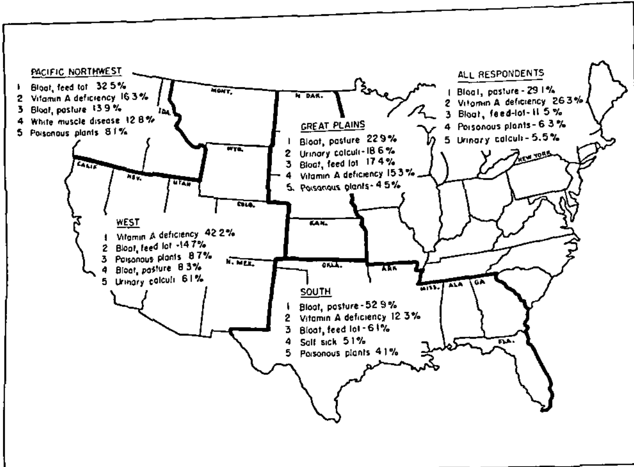


FIG. 117. Five most common beef cattle nutritional diseases and non-infectious ailments in the United States, by area. (Washington Experiment Station.)

diseases were tabulated separately in the above survey, with the results summarized in Table 264 and Figure 117. An annual mortality rate of 0.32 per cent was attributed to diseases and ailments of a non-infectious nature, with 71 per cent of the death losses in this category being due to bloat, poisonous plants, and urinary calculi, listed in order of importance.

Fortunately, the ailments, both infectious and non-infectious, which occur most frequently in beef cattle yield rather readily to simple treatment. There are, however, a few diseases to which beef cattle are subject that are of a dangerous character. Moreover, minor ail-

Table 264

INCIDENCE OF BEEF CATTLE NON-INFECTIOUS AILMENTS AND NUTRITIONAL DISEASES*

Disease or Ailment	Herd Incidence† (%)	Per Cent of Cattle Afflicted
Bloat, pasture	20.91	0.39
Vitamin A deficiency	2.58	0.35
Bloat, feedlot	10.01	0.15
Poisonous plants	10.14	0.08
Urinary calculi	10.39	0.07
Grass staggers	3.15	0.05
Salt sick	1.01	0.04
Fluorine poisoning	0.63	0.03
Pine needle abortion	1.32	0.02
White muscle disease	1.64	0.02
Iodine deficiency	2.02	0.01
Phosphorus deficiency	1.45	0.01
Sweet clover disease	0.57	0.01
X-disease	0.82	0.01
Alkali disease	0.88	0.01
Oat hay poison	0.69	0.01
Poisons, chemical	0.63	0.01
Anemia	0.94	0.01
Acetonemia	1.13	0.00
Molybdenum deficiency	0.06	0.00
Rickets	1.26	0.00
Oak poisoning	0.19	0.00
Prussic acid poisoning	0.13	0.00
Milk fever	0.38	0.00
Diseases not diagnosed	0.38	0.01
Other diseases	0.69	0.04
Total		1.33

* Washington Experiment Station Bulletin 562, 1955

† Per cent of cattlemen reporting the ailment or nutritional disease.

ments, if not properly treated, may quickly develop into serious disorders that may prove fatal. Consequently, the beef cattleman should seek to become proficient in detecting the symptoms of the common diseases and ailments so that proper treatment may be administered before the illness has made extensive progress. Perhaps of even more importance is an understanding of preventive measures which can be taken to prevent or reduce the incidence of the problem in the first place.

Treatment should usually be prescribed by a competent veterinarian Some of the minor ailments, such as scours and bloat, are of such common occurrence as to warrant the keeping on hand of a supply of such medicines as the veterinarian may prescribe, which the herdsman himself may administer. Cattlemen, for the most part, rely altogether too much on home-made remedies and "quack" prescriptions, which are likely to do more harm than good. Even in a disease that has little likelihood of causing death, the expense of calling in a veterinarian is usually justified by a much more rapid recovery of the animal than otherwise would occur.

DISEASES COMMON TO BEEF CATTLE[1]

Anaplasmosis. Anaplasmosis is a serious blood disease of cattle which has not yet been encountered in many sections of the United States However, it is now believed that the disease has been present in the southern states for many years but was not distinguished from Texas fever until that disease had been definitely eradicated. Anaplasmosis resembles Texas fever in that it is caused by a blood parasite which is carried from animal to animal by ticks, horseflies, and mosquitoes. However, whereas Texas fever is transmitted by only one species of tick, the protozoan that causes *anaplasmosis may* be transmitted by more than 25 species of insects. This transmission makes the control and eradication of the disease very difficult. Whereas anaplasmosis has been encountered in nearly all the southern states, the few outbreaks that have occurred in the North have been confined principally to shipped-in cattle which presumably were infected when purchased.

The disease is especially severe in mature cattle, resulting in death losses of 30 to 50 per cent of the animals infected. Calves and yearlings seldom are visibly affected, or else they have the disease in mild form and make a complete recovery. Animals that have the

[1] In the discussion of disease prevention and control, U.S.D.A. ARS 22-30 (1956) was the chief reference.

disease and recover, regardless of age, are immune to future infection but usually remain carriers of the disease throughout life, and when introduced into clean herds they are a source of infection for other cattle.

The symptoms of anaplasmosis may be either chronic or acute. In the acute form the first symptom noted is a high temperature of 103° F. to 107° F. After 2 or 3 days the temperature falls to subnormal, breathing becomes difficult, the mucous membranes are pale and yellowish, and the muzzle is dry. Urination is frequent but the urine seldom is bloody. The patient usually is constipated and either blood or mucus, or both, are voided with the feces. In the acute form of the disease death usually occurs 1 to 5 days after the first symptoms are observed. In the chronic form the infected animals live longer and a greater percentage recover. Recovery of mature animals is usually very slow. Laboratory tests of blood samples should be made to verify a tentative diagnosis, and state and federal veterinarians should be notified.

No specific treatment for the cure of anaplasmosis has been perfected; consequently, treatment varies widely among veterinarians. Good nursing and care, of course, are vital to recovery. Daily transfusions with 2 gallons of normal bovine blood usually save an animal infected with this disease but this treatment is, of course, expensive. Drugs which stimulate blood formation are sometimes helpful, and aureomycin has been reported beneficial in the early stages of the disease. No satisfactory vaccine is currently available but there is a test for the detection of anaplasmosis in the early stages of its development. Man is not subject to this disease.

Anthrax. Anthrax, also called charbon and splenic fever, is a highly infectious disease and is very often fatal. Not only is it transmissible from one animal to another but it may spread rapidly to all species of livestock, and even to man. It is one of the worst scourges of animal life. This disease has existed among European cattle since the early part of the seventeenth century and has caused enormous losses. Its presence in the United States is, in general, confined to certain local areas of rather low, moist land of a more or less mucky character. In such soil the spores of anthrax remain potent for years although no animals whatever graze thereon. Hay grown upon such land may carry the germs of the disease far and wide. The importation of hides has been responsible for outbreaks of anthrax among the cattle in the vicinity of tanneries

Death from anthrax is very sudden; the finding of a dead animal is commonly the first sign of the presence of the disease. In all cases of

sudden death not preceded by symptoms of illness, anthrax should be suspected and the carcass handled with extreme caution until the death can be attributed to some other cause. The characteristic evidences in an animal dead from anthrax are (1) a tarry consistency of the blood, which is of a blackish color and fails to clot firmly, and (2) an enlargement of the spleen of two to five times its normal size. A positive diagnosis, however, can be made only by examining a sample of the blood under a microscope for the presence of the specific bacillus. When anthrax is suspected, a veterinarian should be called without delay. Burning or deeply burying the carcass of the dead animal and the prompt vaccination of all other animals of the herd with anti-anthrax serum, constitute the best known methods of preventing the spread of the disease. Animals showing high temperatures should be separated from the others and given serum plus antibiotics, whereas *others in the herd may be given simultaneous treatment*, consisting of serum and spore vaccine. Those receiving only the serum should be re-vaccinated after several weeks with both serum and vaccine.

Blackleg. Blackleg is an acute, infectious disease, attacking principally cattle between 6 and 24 months of age. It is characterized by marked lameness and pronounced swellings over the shoulders and thighs, due to the formation of gas in the subcutaneous tissues. When pressure is applied to these swellings a peculiar crackling sound is heard, which is the characteristic symptom of blackleg. The disease runs a rapid course and almost always terminates fatally in 12 to 36 hours. Like anthrax, it is more or less restricted to certain regions and even to individual fields where the soil is infested with the spores of the causative organism and where outbreaks commonly occur annually unless prevented by vaccination.

Blackleg is of common occurrence in the western half of the United States, but is especially prevalent throughout the Southwest and on the eastern slopes of the Rocky Mountains. Outbreaks have been reported in nearly all of the Corn Belt states but in the Corn Belt the disease is confined to limited areas.

Prevention rather than treatment is the practical method of combatting the disease. All young cattle brought into a region known to be infected with blackleg should be immediately vaccinated with blackleg bacterin. The bacterin is made by treating cultures of the blackleg organism with formalin to destroy their infectious properties but not their antigenic value. Calves born in a region in which blackleg has occurred even infrequently during the past 10 years should be vaccinated with blackleg bacterin at approximately 6 months of age.

Usually vaccination is performed when the calves are weaned. Man is apparently not susceptible to this disease

Brucellosis. Brucellosis may also be called Bang's disease, contagious abortion, or, simply, abortion Abortion of the infectious type is one of the worst diseases with which cattle breeders have to contend. It is caused, as a rule, by a specific organism known as *Brucella abortus*, although other uterine infections of a more general character may likewise bring about a number of abortions in a herd of cows Apparently infection generally gains access to a new victim through the mouth, having been scattered in the uterine discharge of an aborting animal over grass, hay, and other feed materials, or into the water source. All aborting cows should be segregated from the herd and kept in quarantine until at least 3 weeks after all uterine discharge has ceased, or until a negative blood test has been obtained. Some authorities hold that an infected cow is never rid of the organisms, although she may eventually become sufficiently immune to calve at the normal time. Bulls as well as cows may contract the disease, but here, too, the avenue of infection is thought to be through the digestive tract. The prudent breeder, however, will refrain from mating a bull that he knows is clean with cows that are suspected aborters.

The blood agglutination test furnishes a dependable basis for the control and eradication of brucellosis A more recently developed test known as the "ring test," applied to milk samples, is not highly practical for beef herds but is useful in screening dairy herds for possible suspected animals. In the agglutination test various dilutions of the blood serum are mixed in small test tubes with specially prepared cultures of the *Brucella* bacillus, and the mixture is allowed to stand for 24 to 48 hours. If the animal is "negative," the bacteria remain in suspension, keeping the solution cloudy, but if it is "positive," the bacteria are precipitated to the bottom of the tube, leaving the fluid above them perfectly clear.

There is no known cure for brucellosis. Immunization of heifer calves between 6 and 8 months of age with a standardized live vaccine, *Brucella abortus strain 19*, is a reasonably effective immunizing agent In older animals, immunization may effectively prevent the disease but it interferes with blood agglutination tests, thus making later blood tests difficult to interpret. For this reason, older females are seldom vaccinated. Eradication of brucellosis is usually most successful if pursued on an area plan. Such eradication plans are operated under joint federal-state arrangements. States with less than 1 per cent incidence are called *modified brucellosis-free areas* Individual

FIG. 118. Collecting a blood sample for brucellosis and leptospirosis tests. A pinch or squeeze gate is useful in restraining cattle while the blood sample is drawn.

herds which are tested annually by a state or federal veterinarian and found to be free of reactors in two successive years are designated as *accredited herds*. Federal and state regulations pertaining to the transportation of breeding cattle may vary from area to area and are subject to change, as are the various approved plans for eradication of the disease. Every breeder of beef cattle, therefore, should keep abreast of the latest regulations in effect in his area.

The handling of infected animals or the drinking of milk from infected cows can result in contraction of the disease by man, in which case it is called *undulant fever*. The disease is not often fatal to man but a long, debilitating illness results.

Foot-and-Mouth Disease. Foot-and-mouth disease is not prevalent in either the United States or Canada. It has gained access to the United States on nine different occasions since 1870, but in each instance it has been promptly stamped out by the slaughter of all infected and exposed animals. The wisdom of such measures is amply justified when one considers the terrible handicap imposed by this plague upon the livestock industry of the countries of Europe and South America where the disease is ever present.

The disease was introduced into Mexico in 1947 when a shipment of Brahman bulls was smuggled into the country from Brazil, and only through heroic efforts and the expenditure of more than $100 million by the Mexican and American governments working cooperatively was the disease brought under control. At first an attempt was made to eradicate the disease by the slaughter of all infected and

exposed animals. However, it soon became apparent that this plan was impractical and a program of vaccination and rigid quarantine and inspection was inaugurated.

Foot-and-mouth disease is seldom fatal but it causes enormous losses through the loss of weight suffered while the animals' mouths are so sore that they almost refuse to eat. Recovery is very slow, and many of the animals are hopelessly ruined from the standpoint of the feed lot. There is no specific cure for the disease. Federal-state agreements for prompt cooperative action in case of an outbreak of foot-and-mouth disease can quickly be put into effect. Indemnities are paid in the eradication programs put into action upon diagnosis of the disease. Man is fortunately not subject to foot-and-mouth disease.

Johne's Disease. This disease, also known as paratuberculosis, is believed to be increasing in incidence. The disease is generally spread by the droppings of infected animals which contaminate pastures, water sources, and even feed bunks. An extremely severe chronic and intermittent diarrhea is responsible for the ease of contamination and this diarrhea, along with extreme loss in weight, is the principal outward symptom. Owing to the long incubation period, calves which contract Johne's disease usually do not show symptoms until they are about 2 years old or, in the case of heifers, after they have dropped their first calf. Appetites remain good, temperature and pulse rate are unchanged, but milk production decreases The animals soon become unthrifty and emaciated in appearance, continuing to scour and waste away until death results in many cases. Because these symptoms are similar to the effects of internal parasites and malnutrition, Johne's disease is rather difficult to diagnose. An interdermal injection of johnin, prepared and used in the same way that tuberculin is used for the tuberculosis test, with resultant thickening of the skin in 48 hours, indicates a positive reaction.

No satisfactory treatment is known and satisfactory vaccines are not yet available. A test and slaughter program with payment of indemnities by federal and state authorities has been in operation since 1927. Johne's disease has not been reported in man.

Leptospirosis. The incidence of this rather recently described disease is not too well determined. It has been found in 40 states and seems to be spreading rapidly. As is the case with brucellosis, this disease is spread by urine and discharges from infected animals, with the principal entry being the mucous membranes. Because the kidneys are attacked the urine may be dark red or wine-colored. Abortions may occur when pregnant animals are infected, causing

this disease to be confused with brucellosis. Leptospirosis has a short course of 3 to 10 days, with death losses running as high as one-third in calves.

Treatment is of doubtful value, although antibiotics do sometimes give some relief. A bacterin is being produced, but protection through its use is limited. A serological test has been developed for diagnostic work and it is becoming a generally recommended practice to use the blood samples drawn for brucellosis testing to screen a herd at the same time for leptospirosis.

A few cases of this disease have been found in man. For this reason, until the extent of the danger to human beings is known, the usual antiseptic precautions should be taken in working with cows that abort or show the other symptoms which may indicate presence of leptospirosis.

Mucosal Disease Complex. Several diseases, including rhinotracheitis, mucosal disease, and virus diarrhea, are believed to be caused by several strains of the same virus. The disease has only recently been characterized and it is probably much more prevalent than supposed. At present it is not known how these diseases are spread Symptoms are high fever, nose and eye discharges, salivation, lesions in the membranes of the respiratory and digestive tracts, and diarrhea.

Rhinotracheitis or "red nose" is the most important of the various diseases of the mucosal complex since it appears to be spreading throughout the large feed lots of the West where large cattle numbers are congregated. This disease may often be confused with shipping fever. Weight losses are great owing to severe dehydration. The inflammation is usually confined to the respiratory system and death often results from strangulation.

"Mucosal disease" is an infection confined largely to the digestive tract and occurs in calves more often than the other diseases of the complex. Late winter or early spring is the season of greatest incidence. Symptoms are a rise in temperature to about 106° F. and then a drop to nearly normal. There is loss of appetite, nasal discharge, and diarrhea which progresses with the disease until the feces contain much mucus and blood. Ulcers may be found in the nostrils, on the muzzle, lips, and gums, and in the mouth. Sometimes there are congested areas and hemorrhage in the colon. Death losses in a herd may amount to 20 to 50 per cent of the young stock, and 100 per cent losses have been reported.

Virus diarrhea, another disease of the mucosal complex, affects both the respiratory and the digestive tract. In the early stages of the

virus infections, nasal discharges are present along with superficial mouth lesions. The most characteristic symptom, however, is diarrhea which develops in the later stages of the infection. The watery feces contain mucus and blood as in the case of mucosal disease. Naturally, weight losses are extremely heavy owing to the dehydration resulting both from fever, which may run as high as 108° F, and the diarrhea.

Unfortunately no successful control has been developed for any of the diseases in the mucosal disease complex. Antibiotics and sulfa drugs are often used but serve only to reduce the danger of secondary infections such as pneumonia. There is also no known method for preventing the diseases, but research is in progress which shows some promise. So far as is known, no danger to man exists with regard to this group of diseases.

Shipping Fever. For a number of years this disease has been called hemorrhagic septicemia as well as shipping fever, and more recently the term "stress fever" has come into common usage in referring to this disease. Actually this name is fitting because any sudden change, such as weaning and shipment, or change in weather, which puts a stress or strain on the cattle, and particularly calves, makes them susceptible to the infective agent. Unfortunately the causative organism is as yet unknown but is believed by some to be a virus.

Shipping fever spreads easily from animal to animal upon contact. Contaminated stockyards, sale barns, trucks, and cattle cars, and cattle-working equipment such as chutes and scales, are all good sources of infection. It is not uncommon for a new shipment of stockers or feeders to spread the disease to cattle which may already be on feed.

As indicated earlier, shipping fever is one of the big four in causing cattle death losses. Furthermore, calves or yearlings that have been weakened by shipping fever often fall victim to pneumonia, another of the quartet of heavy killers, which will be discussed in greater detail below.

Shipping fever is a respiratory infection which usually appears in cattle within 10 days of arrival after shipment or within 14 days after first exposure. As seen in Figure 119, a tired, hang-dog appearance is characteristic. Appetites are dull and a mild cough is usually present, although this is more evident when the calves are moved about. Temperatures rise to 107° F. in the more serious cases. Since easily recognized symptoms may not always be present, a check with a rectal thermometer of all calves in a drove is the only way to find those really needing treatment. In the usual outbreak of shipping

FIG. 119. *A case of shipping fever, showing characteristic attitude of weakness and dejection.* (U.S.D.A.)

fever, many calves recover spontaneously but some—and this varies with the virility of the infection and the amount of stress the calves have undergone—contract pneumonia and die if left untreated.

Since it appears that shipping fever is brought about by an impaired condition of the animal, preventive measures rather than a specific cure should be the first concern of the cattleman. Hard driving, overcrowding in cars, insufficient bedding, irregularity in feeding and watering en route, insufficient time to eat, drink, and rest at unloading points, improper handling, and use of unpalatable rations upon the completion of the journey should be avoided. If the cattle arrive during cold weather, especially if it is wet and stormy, adequate shelter should be provided. Sufficient time should be given the cattle to recover from their journey and become accustomed to their new surroundings before they are dehorned or subjected to detailed sorting and so forth. The ration for the first few days should be of good quality, preferably a choice grade of prairie or mixed hay, with perhaps a little silage or some crushed or whole oats after the third or fourth day. During favorable weather the cattle may have the run of a rather short pasture.

The use of serums, mixed bacterins, and aggressins is not recommended for the prevention of stress or shipping fever because, in the absence of knowledge concerning the real cause of the disease, the effectiveness of such injections is questionable. If an outbreak does

occur in spite of all precautions or if, as is most often the case, the buyer had no control over the previous treatment of a shipment of calves, prompt diagnosis and treatment are necessary to keep both weight and death losses low. Immediate treatment with antibiotics or combinations of sulfa drugs and antibiotics on arrival of all calves is sometimes practiced, but unless the calves have had an unusually long and rough trip, such treatment probably is not warranted. Rather, only those calves showing temperatures above 105° F. need such treatment, and the remainder may be cared for in the manner previously described.

Quite recently, preliminary investigations with injections of tranquilizer prior to shipment appear promising. The reduced restlessness could conceivably reduce the stress which the calves experience and therefore could reduce their susceptibility to stress fever. In order for this practice to work, the very practical problem of sorting and handling the calves prior to shipment would have to be met. Ranchers are usually reluctant to add such operations to their established routines, mainly because they usually result in higher labor costs and lighter shipping weights.

High-level feeding of antibiotics, either aureomycin or terramycin, at the rate of 500 mg. daily for 5 days followed by a low level of feeding (70 to 80 mg. daily) for an additional 2 to 3 weeks is recommended by some authorities as a preventive for shipping fever. The problem with this practice is that newly weaned calves are unaccustomed to eating concentrates unless they were previously creep-fed, and creep-feeding has been used in comparatively few instances. Thus the antibiotics, usually contained in a manufactured or commercial pellet or meal, must be fed with a highly palatable feed such as crushed or rolled oats, in order to insure uniform consumption of the antibiotic. All too often the calves which are most apt to contract the disease owing to excessive exposure or rough treatment are also the ones which fail to eat anything but hay or pasture. Mixing the antibiotic-containing supplement with a palatable hay for a few days is probably the best solution.

There is no evidence that human beings contract shipping fever from exposure to infected animals.

Pink Eye. Pink eye is the term commonly applied to an infectious inflammation of the eye, technically called *infectious catarrhal conjunctivitis*. It is usually encountered only during the summer months and is more prevalent in cattle on pasture than in those kept in dry lots. Frequently the disease persists in a herd for several months, during which time nearly all animals are affected in one or both eyes.

The disease is characterized by an intense inflammation of the mucous membrane of the eye and tears mixed with pus which flow down the side of the face. In its most aggravated form it causes a large grayish-yellow ulcer to appear on the cornea, making the eye temporarily blind.

All animals in a herd in which pink eye is present should be examined carefully every day, and those which show symptoms of the disease should be segregated, if possible, in a darkened barn and supplied with plenty of fresh water and succulent feed. Their eyes should be thoroughly cleaned of all dirt and pus by washing them with a boric acid solution made by dissolving 1 ounce of boric acid crystals in 2 quarts of boiling water. After the eyes have been thoroughly washed, a thin coating of 5 per cent sulfathiazole eye ointment should be applied to the affected parts. This ointment comes in a metal tube and can be squeezed directly on and under the eyelids. Antibiotics in fine powder form which can be "puffed" into the eye by squeezing the container are also recommended. Mild cases should be treated daily, and those of more severity at least twice a day, until all discharges cease. Eyes on which ulcers have formed sometimes require treatment over several weeks before they return to normal condition.

Pneumonia. Pneumonia is one of the most common diseases affecting young cattle during the winter months. It is especially prevalent during cold, damp weather and among calves that are subjected to considerable exposure because of poor stabling facilities. The characteristic symptoms are a high temperature of 105° to 107° F ; quick, shallow breathing, with dilated nostrils; and a hard, pounding pulse. By applying the ear to the chest, the rasping sound made by the affected lung can be heard. The animal habitually lies on the side opposite the diseased lung in order to keep the infected organ uppermost. In advanced cases and when both lungs are involved, the animal shows little disposition to lie down. Instead, it takes an unsteady position with head down and forelegs wide apart to make for as much ease in breathing as possible.

Treatment for pneumonia usually consists of the administration of sulfa drugs either alone or with penicillin. Whereas formerly a high percentage of pneumonia cases resulted in death, a large number are now saved by the judicious use of these wonder drugs. Obviously they must be prescribed by a veterinarian. Pending his arrival, the patient should be kept warm by covering with heavy blankets, or, with a young calf, by removal to a heated building. The animal should be kept as quiet as possible since exercise or excitement tends to

aggravate the condition by increasing the pulse and respiration rate.

Scours or Diarrhea. An abnormal looseness of the bowels is a common disorder among young calves kept under insanitary surroundings or fed improper rations. Calves ranging in age from a few days to 3 months are most likely to be affected, although older animals are by no means immune. The condition in reality may not be a disease in itself, but may be the result of an abnormal condition of a portion of the digestive tract which causes the feed to be improperly digested. Prompt treatment should be administered since a calf infected with a bad case of scours derives little nourishment from the milk and feed eaten, and consequently loses flesh rapidly and becomes weak and thin.

Most cases of scours are caused by the presence in the digestive tract of harmful bacteria which bring about the formation of toxic products. The first step in the treatment of scours is the administration of an internal antiseptic, sulfa drug, or antibiotic, that tends to destroy these organisms. In conjunction with this treatment, a mild purgative should be given to rid the system of the objectionable toxins as soon as possible. Many biological supply houses now manufacture internal antiseptics that give good results when used for scours. By administering them according to the directions on the label, along with 4 to 8 ounces of castor oil, depending upon the size of the calf, the trouble is usually checked. In the absence of such a preparation, ½ to 1 teaspoonful of formalin, diluted with a pint of water, may be given. In order that these medicines may bring about the desired result as quickly as possible, the calf's feed intake should be somewhat reduced for 3 or 4 days.

A particularly virulent form of scours, which is highly contagious among the calves of a herd, is characterized by grayish-yellow or dirty white feces with a highly offensive odor. Whenever such symptoms are observed, a veterinarian should be consulted immediately because "white scours" is one of the most serious ailments affecting young calves. White scours appears within 3 days after birth, whereas other diarrheas seldom develop before the calf is a week or 10 days old. This fact helps in differentiating between the two types of scours.

Tuberculosis. Tuberculosis is one of the most serious diseases affecting domestic cattle. It is caused by a specific organism which attacks all parts of the body, but particularly the glands of the lymphatic system. The glands of the neck, chest, and mesentery are most likely to be affected. In advanced cases the disease spreads to all parts of the body, forming huge masses of tubercles which interfere

greatly with the normal functions of the vital organs. The serious nature of this disease is disclosed by the fact that in 1918, of the 11,000,000 cattle slaughtered in federally inspected establishments, nearly 225,000 were found to be affected with tuberculosis, 40,500 of which were condemned as being unfit for food. Not only is the disease highly contagious from one cow to another, but it may be transmitted from cattle to hogs through the manure, and from cattle to man through the milk.

Specific symptoms of tuberculosis are difficult to detect in the live animal. In advanced cases the hair becomes harsh and dry and the animal shows a general rundown appearance. Such symptoms, however, may be brought about by a variety of diseases and they cannot be regarded as conclusive. The correct method of examining an animal for the presence of tuberculosis is by the so-called "tuberculin test." Tuberculin is a laboratory product which, when injected under the skin, causes a characteristic reaction or swelling within 72 hours. (See Figure 120.)

Because there is no method of treating tubercular cattle, all animals reacting to the test are sold for slaughter. Since in most animals the disease has not progressed far enough to affect seriously the value of the carcass for meat, "reactors" should be shipped to markets where they may be slaughtered under federal inspection. The law forbids the sale to local butchers of animals that are known to be tubercular. Under a plan long in force, farmers must submit all their cattle to periodic tests and must add no untested animals to their herds. The testing is done free of charge by a federal veterinarian. Any reactors that are found must be promptly disposed of.

Federal and state governments cooperate in payment of indemnities for cattle slaughtered after a positive reaction to the tuberculin test. Tuberculosis remains a health problem among human beings because so long as a vestige of the disease remains in the cattle herds, the

FIG. 120. A TB reactor. Note the swelling under the tail at the point where the tuberculin injection was made.

danger to humans is present since the disease is transmittable to man. Breeding cattle consigned to purebred auction sales must generally be tested for tuberculosis, brucellosis, and in some cases, leptospirosis, within 30 days previous to the sale. This testing is done to permit entry of animals into accredited areas or across state lines.

NON-INFECTIOUS DISEASES AND AILMENTS

Bloat and Vitamin A deficiency are two conditions coming under this heading which have already been discussed in Chapters 22 and 8, respectively. Others to be mentioned in the following discussion although not causing a large number of deaths, can be particularly trying at times. The order in which they are discussed has no bearing upon their relative importance.

Impaction, Constipation, and Indigestion. Because of the large amount of coarse, dry roughage often consumed by cattle, they are somewhat disposed to develop certain digestive disorders during the fall and winter months. Impaction is the term applied to an abnormal accumulation of material in the paunch Constipation, on the other hand, implies a clogging of the large intestine with hard, dry feces. Indigestion is a more general term referring to both of these conditions, as well as to other digestive disturbances.

The first symptoms of indigestion are usually a loss of appetite and a rise in body temperature. When such conditions are noted, the bedding material should be examined for the amount and character of the recently voided feces. If they are scanty in amount or hard and dry, the patient should be given a strong purgative, such as 2 pounds of Epsom or Glaubers' salts dissolved in a half gallon of water. In the case of impaction, as much as 2 or 3 gallons of water should be given and the left side of the patient powerfully kneaded with the fist to bring about a breaking up and softening of the impacted mass. Constipation ordinarily calls for less drastic treatment. Drenching with 1½ pints of castor oil, 2 quarts of raw linseed oil, or 1½ to 2 pounds of Epsom salts usually brings relief. For calves these doses should be reduced by approximately one-half

Lumpy Jaw or Actinomycosis. Lumpy jaw is a non-contagious disease caused by a fungus which attacks the tissues of the throat, the parotid salivary gland, and the bones of the upper and lower jaws Its presence is indicated by a round swelling, usually quite hard and generally firmly adherent to the surrounding parts. The swelling gradually increases in size until it finally breaks open in the form of an abscess, which discharges thick, creamy pus and becomes filled with raw, bleeding tissue. If not properly treated, the fungus invades

the interior of the jaw bones, causing a loosening of the teeth. Also, growths may be formed in the mouth and pharynx, of such a size as to interfere greatly with eating and breathing.

Not all swellings appearing in the region of the neck are necessarily owing to lumpy jaw. A diagnosis can easily be made by examining a little of the abnormal growth beneath a microscope where the fungus appears to be made up of club-shaped bodies, all radiating from the center of the mass to form a rosette. For this reason the fungus is often called "ray fungus."

Cattle affected with lumpy jaw should be separated from the rest of the herd because there is danger of spreading the disease by scattering the fungus on feed that other animals consume. Animals of no more than market value should be promptly sold where they will be slaughtered under proper inspection. Only in advanced cases of the disease are the carcasses likely to be condemned as unfit for food. Valuable breeding animals that are suspected of having lumpy jaw should be examined by a veterinarian and, if found diseased, should be placed under his care. The most satisfactory treatment consists in the complete removal of the growth by surgery. This is easily accomplished if the growth is not too firmly adherent to the surrounding parts. In such a situation the growth may be cut open, the pus washed out, and the cavity packed with gauze saturated with tincture of iodine. If surgical aid is not available or if the position of the growth is such as to make an operation extremely hazardous, the internal administration of potassium iodide over an extended period may bring about recovery. However, when surgical treatment is possible, it is much to be preferred.

Founder or Laminitis. Founder or laminitis in beef cattle is usually the result of overeating. It most frequently occurs among steers which are put on a full feed of grain too quickly to allow them to become accustomed gradually to their new ration. The intake of absorbable nutrients is much greater than can be utilized by the body, necessitating the oxidation of the surplus in the tissues. In the destruction of the excess nutrients much heat is produced. Also, the amount of blood and the circulation rate are considerably increased in the effort of the blood to dispose of the heavy load of nutrients received from the lymphatic system as quickly as possible. As a result, the capillaries, especially those near the surface of the body and in the extremities, are gorged with blood nearly to the limit of their capacity. The capillaries of the feet, surrounded as they are by the inelastic hoofs, are unable to expand to an appreciable extent. Moreover, the animal after its heavy meal is prone to remain quiet for a considerable time,

thereby depriving the feet of the alternate expansion and contraction of the foot structures which accompany movement and which are so essential to a vigorous circulation of the foot. There is consequently a congestion of the blood vessels of the feet, followed by inflammation of the tissues which is manifested by severe lameness.

Treatment of badly foundered cattle is seldom satisfactory because, as a rule, the condition is not observed until the damage to the feet has been done. If it is detected in its early stages some relief may be had by applying cold packs to the feet or compelling the animal to stand in a pond or stream of cold water. Owing to the intense pain experienced by badly foundered animals in standing and walking, they spend a large amount of time lying down and go for feed and water only when driven by the pangs of hunger and thirst. As a result they frequently lose rather than gain in weight, especially if they were carrying considerable flesh when the attack occurred. Animals only mildly affected need cause little concern, but those badly afflicted should be disposed of as soon as it is obvious that their condition is chronic. If possible, they should be sold to a local butcher since they are likely to lie down and be trampled if shipped to a distant market. Moreover, such cattle do not command satisfactory prices at terminal markets because of their poor appearance

Foot Rot. Foot rot, or foul foot, is most likely to occur in calves and feedlot cattle that are shut up in dirty stables or kept on contaminated pastures during the summer Occasionally, thorns or stones may become lodged between the toes in such a way as to set up inflammation of the skin in the interdigital spaces. Inasmuch as this part of the foot is very sensitive, severe lameness results If prompt attention is not given, the inflammation and swelling may extend well above the hoof and around to the heel.

Treatment consists of cleaning the foot thoroughly and applying a strong antiseptic that destroys the causative organism, *Actinomyces necrophorus,* which has gained access through the skin In mild cases undiluted creolin or iodine suffices, but if the infection is well advanced, a 20 per cent solution of blue vitriol or potassium permanganate is to be preferred. Bandaging the foot and keeping the bandage well saturated with one or the other of these solutions usually effects a cure within 3 or 4 days. Intravenous injections of sodium sulfapyridine are recommended for unbroken cattle that cannot easily be handled.

Foot rot can be largely prevented by keeping the feet properly trimmed and by turning the cattle into dew-laden pastures at night throughout the summer and fall. A shallow box containing air-slaked

lime, through which the animals must walk as they enter and leave the barn, is also an effective method of preventing the disease.

Cancer Eye. Cancer eye or epitheomia is a malignant tumor on the eyeball or eyelid of cattle. The disease is found principally on the ranges of the Southwest, where intense sunlight and irritating dust are believed to be at least indirect causes. Hereford cattle are much more susceptible to eye trouble than Shorthorns; Angus appear to be wholly immune. Apparently the lack of pigment in the eyelid and eyelashes to shield the eye from intense sunlight contributes to the prevalence of the disease. For that reason Hereford cows with a fringe of red hairs around their eyes are highly regarded by many ranchers of the Southwest.

In all probability cancer eye results from an injury to the eye which from lack of treatment develops into a badly infected sore. Usually by the time it is observed it has affected the eyeball or the eyelids to such an extent that treatment, other than surgical, is of little avail. At any rate, if the cow or bull is of great value, it should be treated by a veterinarian. If not, it should be sold for beef.

Urinary Calculi. Much trouble sometimes results from the formation of stone-like mineral deposits in the bladder of male cattle, particularly of steers which are finished on grain sorghum in the Southwest. The calculi cause no noticeable discomfort to the animal unless they enter or block the entrance to the urethra and prevent the normal discharge of urine. When this condition occurs the animal is extremely nervous, refuses to eat, lies down and gets up at frequent intervals, and shows other signs of acute distress. Should the bladder become ruptured, temporary relief may be obtained, but the peritonitis caused by the urine in the abdomen soon results in death. If the bladder does not rupture, death results from uremic poisoning brought about by the continued absorption of urine by the blood. The cause of urinary calculi is not known. There is some evidence that it is associated with mineral metabolism, since the feeding of bone-meal tends to reduce its occurrence. There is also some evidence that it may be induced by a deficiency of vitamin A. The fact that many steers fed threshed grain sorghum and unground sorghum heads at the Texas station developed urinary calculi, whereas those fed ground yellow shelled corn had none, lends credence to this explanation.[2]

Since there is no effective treatment for urinary calculi, feeders living in areas where it occurs should attempt to avoid it by paying close attention to the mineral and vitamin content of the ration and

[2] U.S.D.A. Technical Bulletin 945.

providing an adequate water supply. Frequent salting to induce the drinking of large quantities of water is recommended.

Warts. Warts are small skin tumors which frequently appear on young cattle, especially on the neck, shoulders, and head. They are more often observed during the late winter and early spring, when the skin is in poor condition because of the low sterilizing effect of winter sunlight and perhaps faulty nutrition which lowers the natural resistance of young cattle. It has been demonstrated that warts are caused by a filterable virus which may be transmitted from one animal to another and possibly to other species, including man.

As a rule warts are a temporary condition which eventually disappears. However, their disappearance can be hastened by the daily application of Vaseline or castor oil, which favors their absorption. Their absorption can also be accelerated and their spread to other cattle made less probable by the use of a vaccine consisting of finely ground fresh wart tissue suspended in a salt solution to which formalin has been added to destroy the virus. The feeding of Fowler's solution under the direction of a veterinarian is recommended as an indirect treatment to give tone to the skin.

Ringworm. This skin condition is prevalent during the winter time when cattle may be rather closely confined. It is caused by a fungus and appears as circular patches of roughened, scaly skin over the body but mainly about the head and neck and at the root of the tail. Itching is a symptom easily observed since cattle rub the affected areas, thus further spreading the condition to other parts of the body or to other cattle. Curry combs and brushes can easily spread the condition through an entire show string of cattle; consequently the condition should receive immediate attention once it is observed.

Treatment for ringworm is simple, consisting of scrubbing the affected areas vigorously with soapy water followed by a daubing with

FIG. 121. A severe case of warts. (University of Illinois.)

lime, through which the animals must walk as they enter and leave the barn, is also an effective method of preventing the disease.

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FIG. 121. A severe case of warts. (University of Illinois.)

FIG. 122. A severe case of ringworm. (University of Illinois.)

iodine, lime sulfur, or prepared medicants available from veterinarians. This treatment should be applied every 3 to 5 days until the condition is remedied. Gloves should always be worn when working with cattle infected with ringworm because it is highly transmissible to man.

Hardware Disease. This condition carries its descriptive name because it is caused when such objects as nails, pieces of baling wire, or parts of machinery are picked up by cattle, accidentally during eating or through curiosity, and swallowed into the reticulum or honeycomb, one of the rumen compartments. There the sharp edges or ends of the objects may puncture the stomach wall, passing into the pericardial cavity where they may cause immediate death by injury to the heart, or cause an accumulation of fluids which eventually leads to death. Symptoms of the disease are a rapidly developing, unthrifty condition, swellings in the brisket region, a sound of fluid movement in the heart and lung regions, and obvious pain when the animal moves about. Treatment is seldom successful and most cases are inoperable. However, when cases involving extremely valuable animals warrant the expense, objects which can be located by fluoroscopic examination are sometimes surgically removable by entry through the paunch wall.

Mineral deficiencies, especially of phosphorus, often are responsible for animals picking up metal objects. Correction of the deficiency and careful removal of all bits of wire, et cetera, from paddocks and feed lots reduces the incidence of this problem. The use of magnetic metal arresters in feed mills removes a large part of the metal objects often responsible for the condition.

POISONOUS METALS AND PLANTS

The sickness and death of cattle due to eating poisonous plants and other harmful materials are of infrequent occurrence in the non-range areas. In these sections of the country the number of plants that are poisonous to livestock is small compared with the number found in the range area. Also the feed supply is usually sufficient to cause animals to pass by poisonous plants, nearly all of which are quite unpalatable compared with good, wholesome forage. However, it occasionally happens, especially in early spring and during prolonged periods of dry weather, that pastures are so short and bare that cattle begin to eat any vegetation available, especially weeds and shrubs that are still green and succulent.

The majority of poisonous plants are found principally in moist, shaded regions, especially in the areas near ponds and streams The forage of timbered and marshy pastures should be examined closely each year to see if there are plants there which are poisonous to livestock. If any are found, careful watch should be made to detect the first tendency of the cattle to eat them.

Treatment of animals that have eaten poisonous plants should be prescribed by a veterinarian. Remedies given by mouth are often of little value in overcoming the toxic effect of poisons owing to the huge volume of the digestive tract in cattle and the great mass of stomach and intestine contents that must be reached by the drugs. "Reliance must be mainly on prevention and upon such remedies as will increase elimination. A laxative or purgative is always helpful and for this purpose Epsom salts may be given in pound doses, or raw linseed oil in doses of 1 or 2 pints."[3]

Common Crowfoot. This is a common weedy wild flower of the buttercup family that is found in meadows and pastures. The juices of the plant are extremely acrid and cattle usually will not eat it except in the early spring when first turned onto pasture Several varieties of crowfoot are found in the Central States; nearly all are more or less poisonous in the green state but harmless after being cut and dried. The stems, which vary greatly in height according to species, are smooth, hollow, and very much branched. The flowers are small with pale yellow petals surrounding a prominent seed head.

Symptoms of crowfoot plant poisoning are gastric enteritis, diarrhea

[3] *Diseases of Cattle*, U.S.D.A., revised edition, 1942 Extensive use has been made of this excellent book in describing the symptoms produced by the poisonous plants which are listed.

with excretions of black, foul-smelling feces, together with nervous symptoms such as difficult respiration, slow chewing of cud, and jerky movements of ears and lips which are sometimes followed by convulsions and death in a few hours.

Ergot. Poison from ergot occurs chiefly during the winter and spring when considerable amounts of grain and cured roughages are being fed. Ergot affects the seeds of some plants, making them hard, black, somewhat curved in shape, and several times larger than natural. Of the grains, rye is most likely to be affected, while bluegrass, fescue, and redtop hays are highly susceptible to ergot.

Ergotism in cattle is of two types, the spasmodic and the gangrenous. In the former type the symptoms are muscular trembling, convulsions, and delirium. Abortion is often brought about by this form of ergot poisoning. In the gangrenous type there is a mummification and sloughing off of the extremities such as ears, tail, feet, etc., through a degeneration of the small blood vessels supplying those parts. Treatment of animals with marked symptoms of ergotism is of little avail. Destruction is recommended except in the case of valuable breeding animals.

Fern or Bracken. The common fern or bracken which grows in moist, shaded spots in woods and along streams often causes poisoning in cattle. The early symptoms are unsteady gait, loss of appetite, constipation, nervousness, and congestion of the eyes. These symptoms are followed by a spreading apart of the legs in an effort to maintain balance, extreme nervousness, and a general loss of muscular control.

Jack-in-the-Pulpit or Indian Turnip. This is a plant of the arum family found growing in wooded areas. It is easily recognizable by its peculiar purple-striped, vase-shaped flowers with large erect stamens and pistils. The poisonous nature of this plant has been observed only recently and few data are available concerning the specific symptoms exhibited by cattle which have been poisoned from this source. However, there appear ample reasons for classifying it among the plants dangerous to cattle.

Henbane and Jimson. These weeds, which belong to the nightshade family, are coarse, smooth-stemmed, ill-scented plants that inhabit neglected fields and waste places. They prefer a rich soil and are often found in old feed lots and in fields which have been heavily manured. Poisoning is most likely to occur when good grazing is scarce or when hungry feeder cattle are turned into infested lots upon their arrival at the farm.

The common symptoms of nightshade poisoning are unsteady gait,

cramps, convulsions, and loss of consciousness. Respiration is difficult, and the pulse very rapid. Fortunately cattle seldom eat these weeds except when forced to do so by extreme hunger.

Water Hemlock. This plant is one of the most deadly that may be eaten by cattle. The root is the harmful part, and losses are most severe during the early spring when the ground along streams is badly eroded by high water. Also, at this season the roots may be pulled up by cattle grazing the green tops of the plants. Symptoms of hemlock poisoning are intense nervousness, frothing at the mouth and nose, and violent convulsions Death frequently occurs within an hour after the root of a single plant is eaten.

White Snakeroot. White snakeroot is a rather large, coarse perennial weed which is found in many woodland pastures throughout the Central States. It can be identified rather easily by its leaves, "which are opposite each other, 3 to 5 inches long, broadly ovate, with sharply toothed, or serrated edges. Each leaf stalk has three main

FIG. 123. White snakeroot (*Eupatorium urticaefolium*). (Illinois Experiment Station.)

veins which extend from the base of the leaf and which give off many branches. These veins are prominent on the under surface. In the late summer the white flowers of the plant appear as compound clusters having 8 to 30 flowers."[4]

Poisoning from white snakeroot occurs usually during the late summer and autumn when pastures are dry and brown. Affected cattle show a peculiar trembling of the muscles, which accounts for the name "trembles," applied to the disease in certain localities. This trembling is most pronounced after exercise and tends to disappear following rest. Constipation, general weakness, loss of weight, and incoordination of the voluntary muscles are associated with the disease

Cows affected with snakeroot poisoning secrete the toxic principle of the plant in the milk. There is thus great danger that the disease may be transmitted to human beings, calves, and other animals that are fed milk from cows running in pastures infested with snakeroot plants.

Sorghum Poisoning. Under certain conditions growing sorghum becomes a dangerous feed for cattle because of its high content of hydrocyanic acid. Severe drought and frost appear to promote the formation of this poisonous material in sorghums, especially in the second growth that springs up after the main crop has been cut and shocked or harvested for silage. The grazing of sorghum stubble should be done with extreme caution so that the first signs of illness are detected and the animals removed from the field. Feeding the harvested fodder or silage causes no trouble, even in the case of frosted sorghum or sorghum badly fired from drought. Intravenous injections of sodium thiosulfate are used by veterinarians in treating the condition The consumption of considerable wild cherry foliage can cause the same poisoning.

Lead Poisoning. Cattle appear to have a liking for paint, and numerous losses have occurred from their licking buildings and fences that are covered with a lead-containing paint. There have even been instances in which a single old paint bucket thrown on a rubbish pile has been responsible for the death of several valuable animals. Cattle have also been poisoned from eating silage from a silo that was filled before the lead paint on the inside walls was dry. The symptoms of lead poisoning are general dullness, convulsive movements of the limbs, champing of the jaws, and violent bellowing, followed by prolonged stupor and death. Lead acts as a toxin which is particularly damaging to the kidneys, resulting in perforation of the glomeruli.

[4] Illinois Circular 295.

Use of non-lead paints has reduced the incidence of lead poisoning but when old lead paints have only been covered over by the new, safe kinds, access to the lead-containing paint is still possible. If detected in its early stages, lead poisoning may be arrested by certain injections into the blood stream which prevent the lead from reaching the kidneys. Consultation with a veterinarian is essential in the treatment of this condition.

chapter 30 PARASITES AFFECTING BEEF CATTLE

Internal and external parasites of beef cattle are responsible for rather serious monetary losses in individual areas, and for smaller losses in almost all situations, unless preventive and control measures are applied. Unfortunately, many of the losses are not very obvious and consequently do not seem to be of importance to many cattlemen. Undoubtedly the judicious use of insecticides is the best investment a cattleman can make in terms of net return per unit of investment.

The incidence of recognizable cases of harmful parasitism is difficult to assess. The Washington Experiment Station survey, discussed in Chapter 29, is the most comprehensive recent study of this problem. Figure 124 shows the percentage of farms and ranches which reported parasite problems. (The rank of each type of parasite is not necessarily the proper rank from the standpoint of monetary losses.) Note that screwworms are particularly important in the South, whereas lice and hornflies are important in all of the areas surveyed. When cattlemen were asked for their opinion of the most damaging parasites, they ranked lice, grubs, screwworms, and hornflies at the top, as shown in Figure 125. Diseases such as anaplasmosis and coccidiosis were included by many cattlemen because parasites are responsible for their transmission, as was mentioned in Chapter 29.

The Washington survey revealed some interesting information concerning the extent to which control measures were applied by cattlemen. The results, shown in Table 265, indicate that lice, hornfly, and grub control measures were applied by about 40 per cent or more of those answering the questionnaire. It is known by the author that screwworm control measures are applied almost 100 per cent throughout the South and, further, that the use of control measures for intestinal parasites has increased in the South in recent years. The recent development of systemic phosphates for grub control will receive much attention in the near future in coping with this problem.

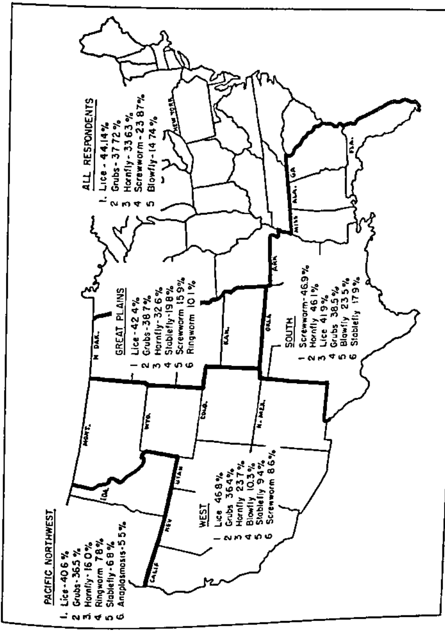

FIG. 124. Six most common beef cattle parasites in the United States, by areas. (Washington Experiment Station)

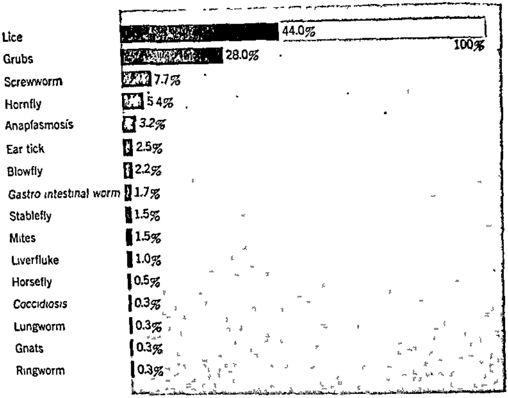

FIG. 125. Most damaging beef cattle parasites in the United States, as indicated by percentage of herds affected. (Washington Experiment Station.)

Table 265

PERCENTAGE OF CATTLEMEN APPLYING BEEF CATTLE PARASITE CONTROL MEASURES*

Parasite	Cattlemen Applying Control Measures (%)
Lice	52.7
Hornfly	41.2
Grubs	37.7
Screwworm	24.8
Stable fly	19.3
Blowfly	15.6
Mites	5.8
Ringworm	5.2
Gastro-intestinal worms	4.7
Coccidiosis	2.8
Liver fluke	2.5
Anaplasmosis	2.3
Cattle tick fever	1.3
Lungworm	0 8
Bovine trichomoniasis	0.4
Others	2.5

* Washington Experiment Station Bulletin 562, 1955.

Any discussion of control measures for parasites is apt to be subject to criticism or to change because developments in this area of research are in an era of rapid accomplishment For this reason, readers would do well to keep closely in touch with the research work of entomologists and parasitologists. This can easily be done by reading releases from extension specialists, experiment stations, and industrial organizations.

Many parasitic infestations are geographic in nature and consequently only a few recommendations concerning use of certain sprays, vermifuges, and so forth, are applicable throughout the country.

COMMON EXTERNAL PARASITES OF CATTLE

Flies. The *hornfly* is the most damaging fly among those which are harmful in adult form. This fly feeds on the backs, necks, and at the base of the horns of cattle. Thousands may be found at one time on a single animal and since each fly feeds several times daily by sucking the blood, the afflicted animal experiences much annoyance and disturbance along with loss in vitality and poor performance due to loss of blood. Hornflies may be almost eliminated by spraying all cattle thoroughly with a fly control spray at the beginning of the grazing season and about once a month throughout the summer. Spray made from either the liquid or powder form of DDT is very effective against hornflies.

Toxaphene sprays last somewhat longer but should not be used within 4 weeks of slaughter. The use of any type of sprayer which covers the entire body of the animal is recommended Expensive high-pressure sprayers are not essential for controlling hornflies. Oil-saturated back rubbers are effective in smaller farm herds Very efficient back rubbers can be made from strands of barbed wire and burlap bags and, of course, others can be bought from equipment supply houses. They should be saturated weekly with either 5-per cent DDT, toxaphene, or methoxychlor, mixed with diesel oil or fuel oil (not crankcase or lubricating oil).

Stable Flies. *Stable flies* are much more difficult to control than are hornflies, since they appear to become resistant to many fly spray materials after a few years. This species of fly is most troublesome around barns and feed lots, where it breeds in wet straw, manure, spoiled feed, and other kinds of filth. Stable flies can be greatly reduced by frequently cleaning lots and sheds and by plowing under the manure or piling it at least a half mile from the barns.

Spraying the legs of cattle with pyrethrins, at levels recommended

by the manufacturers, controls stable flies. The same treatment is recommended for *horseflies,* which suck blood from the backs of cattle.

Ox Warbles. The ox warble, or grub, is a serious cattle parasite in nearly all parts of the northern hemisphere. It has long been present in every state of the United States, although in many localities it is of little economic importance. The degree of infestation appears to vary from year to year even in highly infested areas. This variation leads to the belief that the grub population is affected by climatic conditions, particularly severe cold weather, since the pupa stage of the insect is spent in the ground. The heaviest infestations are found in the Southwest, and it is possible that most of the severe outbreaks of this parasite in the Corn Belt originate principally with feeder cattle from that region.

The adult fly, commonly known as the heel fly and somewhat resembling a small black bee, appears on the first hot days of summer. It proceeds to deposit clusters of eggs on the skin of the host, fastening them to the hairs about the feet and legs, especially to those just above the heel. Although the flies can neither bite nor sting, cattle show a natural dread of them and often run frantically from one end of the pasture to the other, holding their tails high in the air, attempting to escape. Yearlings are more likely to be attacked than calves, and calves more than adults. Since the insects do not fly over water, cattle frequently protect themselves by retreating into ponds and streams.

The larvae, which hatch in 4 to 6 days, immediately penetrate the skin at the base of the hairs to which they were attached. They then proceed, by no well-defined route, to the region of the neck, where they gather about the esophagus. No plausible reason has as yet been advanced to explain why the grubs congregate near the esophagus. It was once believed that the maggots gained entrance to the body of the host through the mouth and that they punctured the esophagus on their way to the back. This theory is now disproved and the presence of a few larvae in the gullet is thought to be wholly incidental. During winter, probably in February and March in the Corn Belt but as early as October in cattle from the South or Southwest, the larvae leave the neck region and migrate to the back, where they form the characteristic swellings beneath the skin. Here a hole is made through the hide, toward which the larva directs its posterior end. In this position the larva increases rapidly in size. The pus and mucus caused by its presence constitute the food material from which this growth is effected. During this time at least two metamorphoses are known to occur by means of which the larva becomes larger and

stouter. Finally, with the arrival of spring, the grub, now fully grown, works its way through the hole in the skin and falls to the ground, where it pupates previous to its transformation into a mature fly when it begins the cycle over again.

The numerous holes made by grubs in the backs of cattle greatly lessen the value of the hides, and the beef in the vicinity of the grubby lesions often is slimy and has a bad color Badly damaged carcasses require extensive trimming in the valuable loin region Altogether the total economic loss to the country occasioned by the heel fly is estimated at nearly $100,000,000 a year.

The recommended treatment is to spray or dust with rotenone, beginning when the grubs are well developed, repeating the spraying or dusting every 30 days. The initial treatments may begin as early as November in southern cattle but native cattle in the Middle West may not require attention until February. Cattle raised in the Northwest, North, and Northeast seldom are affected by grubs. Cattle shipped in from the areas where flies may overwinter are affected the first winter but probably not thereafter.

There is currently much interest in several new compounds for the control of grubs called systemic phosphates, among which "Trolene" and "Co-Ral" are the most common at present. These two materials are used as a bolus and as a spray, respectively. The absorbed phosphatic material apparently destroys the larvae while circulating within the body and thus prevents the damaging effects in the backs of the cattle. These compounds hold great promise because if all cattle are

FIG. 126. A hide, badly damaged by ox warble larvae. Note encysted larva at right. (Livestock Conservation, Inc., Chicago, Illinois.)

effectively sprayed or dosed, the life cycle of the heel fly will be broken and reinfestation will be prevented. Unfortunately, not only is it impractical to spray some cattle, but wild animals such as deer also harbor the ox warble.

Screwworms. Screwworms are the maggots of the fly *Chrysomyia*, sometimes confused with the greenish "blowfly," that is observed about dead animals and those suffering from neglected wounds during the summer months. These flies deposit their eggs in cuts, wounds, navels of newborn calves, and open sores, where they hatch within 2 or 3 days into the so-called screwworm larvae. These maggots burrow deep into the surrounding flesh, greatly aggravating the seriousness of the sore. Freshly cut horn stubs, castration wounds, and neglected injuries are especially likely places of attack. Screwworms are not especially troublesome in the Corn Belt, the Northeast, or the Northwest. It is in the South and Southwest that they cause the greatest injury.

Treatment for screwworms consists first in applying an antiseptic and fly repellent which prevents the deposit of eggs in the wound. "EQ335," which was developed by the United States Department of Agriculture, is the preparation now recommended for this purpose. The remedy contains 3 parts lindane, 35 parts pine oil, 42 parts mineral oil, 10 parts emulsifier, and 10 parts of a silica gelatin. "Smear 62" is also a recommended remedy, but it deteriorates somewhat during storage. When applied to wounds with a brush, these compounds kill maggots deep within the wound, young maggots as they hatch from eggs, and flies attracted to the wound to feed and lay more eggs. Wounds should be watched carefully and re-treated at 7-day intervals until they are healed. The prevalence of screwworm infestation may be reduced greatly by burning or burying deeply all animal carcasses, since they are practically the only medium in which breeding occurs.

Lice. Cattle are subject to three species of lice: long- and short-nosed blue sucking lice, and the red biting louse. (See Figure 127.) Inasmuch as the biting lice feed principally on the particles of hair and dead skin, they are not especially troublesome. The sucking lice, however, cause the cattle much annoyance and, if numerous, sap large quantities of blood. Lice-infested cattle spend much time rubbing themselves against posts, trees, and so forth, in an effort to allay the intense itching. Frequently large patches of hair are worn off and the hide becomes hard and calloused.

Lice are most numerous during the late winter and spring. Cattle on pasture are seldom troubled with them. Treatment should be begun in the fall by dipping or thoroughly spraying or washing all cattle with a solution of any one of five compounds known as chlorinated hydro-

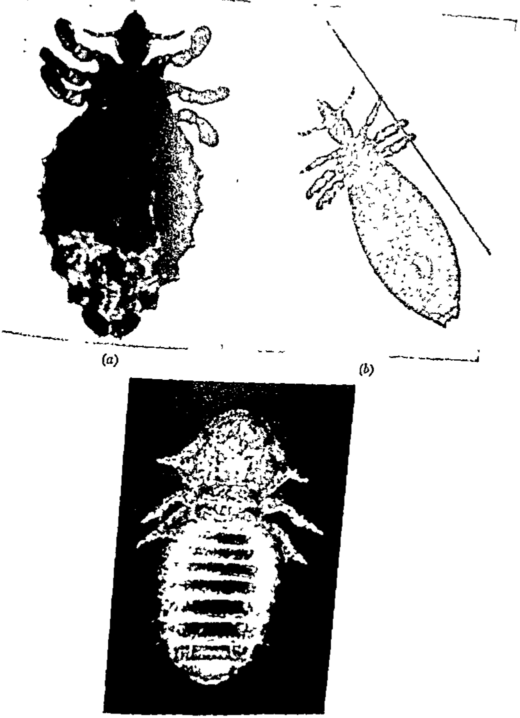

FIG. 127. Types of cattle lice. (*a*) Short-nosed cattle louse (*Haematopinus eurysternus*), adult female, × about 30; (*b*) long-nosed cattle louse (*Linognathus vituli*) on cattle hair, adult female, × about 30; (*c*) biting louse of cattle (*Bovicola bovis*), adult female, × about 30 (Cornell University Agricultural Experiment Station Bulletin 832.)

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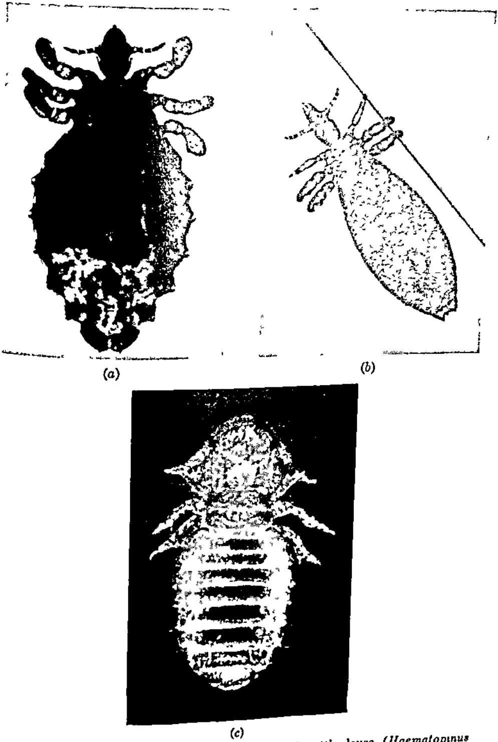

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carbons: DDT, BHC, lindane, toxaphene, or chlordane. DDT has been more thoroughly tested as a dip, and single dippings with suspensions containing 0.25 to 0.50 per cent of DDT have completely eradicated all kinds of lice. To be completely safe, a second dipping should be made within 15 or 16 days in order to kill those lice which may have hatched after the first dipping. The five compounds mentioned above should not be used on producing dairy cows or cattle that are to be slaughtered within 30 days because of the hazard to human health. Rotenone dips and sprays should be used in the unsafe situations just mentioned.

Treating cattle against lice is difficult during cold weather, inasmuch as spraying or dipping may cause colds and pneumonia. *If numbers are small, dipping is also not practical and other treatment* methods must be used Dusting with rotenone, pyrethrum, or the powder form of any of the five chlorinated hydrocarbons recommended above as dips effectively controls lice. Dusting powders can be economically prepared by thoroughly mixing 1 part, by weight, of finely ground active ingredient with 9 to 10 parts of very fine, wettable sulfur. Other suitable diluents or carriers are talc and kaolin. Spot-dusting of the affected areas on a few cattle generally does not solve the louse problem because the lice simply move to non-treated areas or to other cattle. To be effective the treatment should be applied to all cattle in a herd or drove.

Mange or Itch. Mange of cattle is caused by small mites which attack the skin, causing it to become thickened, covered with crusts, and devoid of hair. As a rule, the rump is the part of the body most likely to be affected, although the back and shoulders may also be included. In many respects mange of cattle resembles the disease known as "scab" in sheep, although it is by no means regarded as being so serious Treatment consists in liberal applications of a solution of lime-sulfur or a nicotine dip. In mild cases when only a small portion of the body is affected, an ointment made of flowers of sulfur and lard often effects a cure.

Internal Parasites. The situation with regard to the incidence of stomach and intestinal worms in beef cattle is not clear-cut at the present time. Research has shown that cattle are hosts to many species of worms, and parasitologists say they can find worm eggs in nearly every sample of feces examined under the microscope. The problem is that differentiation between the harmful and harmless types on the basis of fecal examination alone is extremely difficult—in fact, almost impossible—with presently available methods.

The damage or losses incurred due to internal parasite infestation

are as difficult to assess as is the degree of infestation or the type of worms present. Few death losses occur; rather, the losses are in terms of slower gains on pasture or in the feed lot, digestive disturbances which reduce efficiency of feed conversion, or lighter calf weaning weights due to reduced milk flow in the mother cows. In general, internal parasite damage is higher in areas of high rainfall such as the coastal regions, but other areas such as irrigated pastures or well-watered pastures in the mountain ranges may be just as hard hit.

Symptoms of severe infestation with internal parasites are diarrhea, anemia, poor performance in general, and lowered resistance to disease. Swellings under the jaw are generally seen in extremely heavy infestations, and death may result in younger animals if the situation is not alleviated. Worm eggs are expelled in the feces of infested cattle, after which the resulting larvae contaminate the grass, making possible the spread of the infestation to clean cattle.

Phenothiazine, consumed daily at the low level of 1.5 to 2.0 grams, aids in controlling internal parasites. Such constant low levels of consumption can be maintained by mixing salt or a mineral mixture and phenothiazine in the ratio of 10:1 and feeding it free-choice. For treatment of heavily infested cattle, the oral administration of 20 grams per hundred pounds of body weight, but not over 70 or 80 grams total, as a bolus, capsule, or drench is recommended. Mixing the phenothiazine in the feed is not so successful because it is unpalatable and because each animal might not get the correct dosage. The day following such treatment the urine is quite red in color but this is no cause for alarm.

MISCELLANEOUS PARASITIC DISEASES

Trichomoniasis. Trichomoniasis is a venereal disease of cattle caused by an amoeba-like organism which infects the reproductive tract of both cows and bulls. A veterinarian may diagnose the disease from the presence of the flagellate organisms in vaginal or cervical smears examined under a low-power microscope. The organism is more difficult to obtain from the sheath of the bull; consequently his infection is more readily confirmed by mating him with a virgin heifer and checking her uterine and cervical smears for the organism at her next heat period.

Infection of cows results in a mild inflammation of the vagina and uterus with an accompanying discharge which reduces the likelihood of conception, or which may cause abortion, especially during the

second to fourth month of gestation. Frequently, however, the dead, macerated fetus remains in the uterus, which becomes filled with a thin, grayish-white, almost odorless fluid. When this condition occurs the cow seldom exhibits any symptoms of illness except that she fails to show the usual signs of approaching parturition. Should abortion occur, she may come in heat within a few days, which fact is a basis for distinguishing this type of abortion from that caused by the brucellosis bacillus.

Bulls infected with trichomoniasis frequently show no visible signs of the disease, although usually there is a mild inflammation of the prepuce and penis during the early stages. The disease is often transitory in cows but it usually is chronic in bulls, which reinfect the cows each time they are bred. If infected bulls are sold for slaughter and breeding operations discontinued for at least 3 months, the disease usually disappears from the herd.

Vibrionic Abortion. This is an infectious type of abortion caused by a small, comma-shaped protozoan that attacks the capillaries of the maternal and fetal placentae, interfering with the nutrition of the fetus and thereby causing its death and expulsion. This type of abortion differs from brucellosis in that it tends to be more prevalent in older cows than in young cows and heifers and often causes abortions through three or four successive pregnancies in contrast with the immunity frequently acquired after one or two abortions from brucellosis. Another difference usually noted between the two diseases is that the fetus is more or less decomposed when the abortion has been caused by vibrio organisms. However, the only certain method of diagnosing the disease is to identify the vibrio under the microscope. The organism usually can be found in cultures made from the liver, stomach contents, and heart blood of the aborted fetus, but especially in cultures made from the kidneys. The disease also may be diagnosed by an agglutination test similar to that used in diagnosing brucellosis.

Vibrionic abortion of cattle is comparatively rare in the United States and has been reported in only a few areas. It is, however, rather common in sheep and frequently is the cause of large numbers of dead lambs. No effective treatment for the disease is known. Control measures, therefore, consist in the isolation of all suspected cows, pending the completion of microscopic and agglutination tests, and their sale for slaughter if the findings are positive.

APPENDIX

Table 1

AVERAGE COMPOSITION AND DIGESTIBLE NUTRIENT CONTENT OF COMMON FEEDSTUFFS*

Feedstuff	Total Dry Matter (%)	Protein (%)	Digestible Protein (%)	TDN† (%)	DE‡ (therms/lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg./lb.)
Dry roughages								
Alfalfa hay, all analyses	90.5	15.3	10.9	50.7	1.02	1.47	0.24	8.2
Alfalfa hay, 1/10 to ½ bloom	90.5	15.4	11.2	51.4	1.04	1.47	0 24	20.3
Alfalfa hay, ½ to full bloom	90.5	14.1	10.2	50.3	1.02	1.22	0.22	8.5
Alfalfa hay, past bloom	90.5	12.9	9.3	47.7	0.96	1.10	0.20	3.3
Alfalfa meal, dehydrated	92.7	17.7	12.4	54.4	1.10	1.60	0.26	42.4
Alfalfa leaf meal, dehydrated	92.7	21.1	16.0	57.2	1.16	1.69	0.25	62.9
Barley hay	90.8	7.3	4.0	51.9	1.05	0.26	0.23	...
Barley straw	90.0	3.7	0.7	42.2	0.85	0.33	0.10	...
Birdsfoot trefoil hay	91.2	14.2	9.8	55.0	1.11	1.60	0.20	19.7
Bromegrass hay, all analyses	88.8	10.4	5.3	49.3	1.00	0.42	0.19	...
Clover hay, alsike, all analyses	88.9	12.1	8.1	53.2	1.07	1.15	0.23	...
Clover hay, crimson	89.5	14.2	9.8	48.9	0.99	1.23	0.24	..
Clover hay, Ladino	89.5	18.5	14.2	59.5	1.20	1.53	0.29	..
Clover hay, red, all analyses	88.3	12.0	7.2	51.8	1.05	1.28	0.20	7.3
Clover and mixed grass hay, high in clover	89.0	9.6	5.5	51.8	1.05	0.88	0.21	6.1
Clover and timothy hay, 30 to 50% clover	88.1	8.6	4.7	51.0	1.03	0.69	0.16	...
Corn cobs, ground	90.4	2.3	0.0	45.7	0.92	0.11	0.04	...
Corn fodder, medium, in water	82.6	6.8	3.3	53.9	1.09	0.25	0.14	1.8
Corn stover, medium, in water	80.3	5.8	2.0	45.5	0.92	0.48	0.08	...
Cowpea hay, all analyses	90.4	18.6	12.3	51.4	1.04	1.37	0.30	...

Kafir fodder, very dry	90.0	8.7	4.5	53.6	1.08	0.35	0.18	2.0
Kafir stover, very dry	90.0	5.5	1.9	51.3	1.04	0.54	0.09	1.1
Lespedeza hay, annual, before bloom	89.1	14.3	7.2	49.2	0.99	1.03	0.20	20.4
Lespedeza hay, annual, in bloom	89.1	13.0	6.4	46.4	0.94	1.00	0.19	...
Lespedeza hay, annual, after bloom	89.1	11.5	3.6	39.6	0.80	0.90	0.15	...
Mixed hay, good, less than 30% legumes	89.2	8.8	4.8	48.8	0.99	0.90	0.19	6.4
Oat hay	88.1	8.2	4.9	47.3	0.96	0.21	0.19	...
Oat straw	89.8	4.1	0.7	44.8	0.90	0.24	0.09	...
Orchard grass hay, good	88.7	8.1	4.2	49.7	1.00	0.27	0.18	...
Pea hay, field	89.3	14.9	10.6	55.1	1.11	1.22	0.25	...
Peanut hay, mowed	91.4	10.6	6.9	58.4	1.18	...	...	8.0
Prairie hay, western, cut in mid-season	91.3	6.0	2.0	45.1	0.91	0.33	0.12	9.1
Prairie hay, western, mature	91.9	4.4	0.9	43.7	0.88	0.36	0.08	3.6
Quack grass hay	89.0	6.9	2.5	40.3	0.81	...	...	...
Reed canary grass hay	91.1	7.7	4.9	45.1	0.91	0.33	0.16	...
Rye hay	91.3	6.7	2.4	42.5	0.86	...	0.18	...
Rye straw	92.8	3.5	0.0	42.2	0.85	0.26	0.09	...
Sorghum fodder, sweet, dry	88.9	6.2	3.3	52.4	1.06	0.34	0.14	1.1
Soybean hay, good, all analyses	88.1	14.6	9.8	48.6	0.98	1.10	0.22	13.6
Soybean hay, in bloom or before	88.0	16.7	12.0	52.4	1.06	1.29	0.34	...
Soybean hay, seed developing	88.0	14.6	9.8	48.2	0.97	1.24	0.25	13.6
Soybean hay, seed nearly ripe	88.0	15.2	10.8	54.0	1.11	0.96	0.31	3.0
Soybean straw	88.9	3.9	1.1	38.6	0.78	...	0.05	...
Sudan grass hay, all analyses	89.4	8.8	4.3	48.6	0.98	0.36	0.27	...
Timothy hay, all analyses	89.0	6.6	3.0	40.1	0.99	0.35	0.14	4.4

* *Nutrient Requirements of Beef Cattle*, revised 1958, National Research Council.

† In calculating the values for total digestible nutrients, digestion coefficients for a few feedstuffs were unavailable or inadequate; in these cases digestion coefficients for comparable feedstuffs were used.

‡ DE (digestible energy) may be converted to metabolizable energy by multiplying by 82 per cent.

Table 1 (Continued)

Average Composition and *Digestible* Nutrient Content of Common Feedstuffs*

Feedstuff	Total Dry Matter (%)	Protein (%)	Digestible Protein (%)	TDN† (%)	DE‡ (*therms/* lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg./lb.)
			Dry roughages (Continued)					
Timothy hay, before bloom	89.0	9.7	6.1	56.6	1.14		.	9.2
Timothy hay, full bloom	89 0	6.4	3 2	51.1	1.03		0.20	4.2
Timothy hay, late seed	89.0	5.3	1.9	41.9	0.85	0.14	0.15	2.5
Timothy and clover hay, ¼ clover	88.8	7.9	4.0	49.8	1.01	0.58	0.15	
Vetch and oat hay, over ½ vetch	87.6	11.9	8.4	50.7	1.02	0.76	0.27	.
Wheat hay	90.4	6.1	3.3	46.7	0.94	0.14	0.18	...
Wheat straw	92.6	3.9	0.3	40.6	0.82	0.15	0.07	.
			Silages, roots, and tubers					
Alfalfa, not wilted, no preservative	24.7	4.1	2.6	13.5	0.27	0.35	0 08	15.1
Alfalfa, wilted	36.2	6.3	4.3	21.5	0.43	0.51	0.12	11.4
Alfalfa-molasses, not wilted	26.8	4.1	2.7	15.4	0.31	0.41	0.08	14.5
Beet top, sugar	31.6	3.8	2.5	14.9	0.30	0.31	0.07	5.1
Cabbage, entire	9.4	2.2	1.9	8.1	0.16	0 06	0.03	...
Carrots, roots	11.9	1.2	0 9	10.3	0.21	0.05	0.04	...
Clover, Ladino, and timothy	29.9	5 4	3.9	21.4	0.43	0.31	0.07	15.6
Corn, canning factory waste	22.4	2 0	1.1	16.1	0.33	...	...	...
Corn, dent, well matured, all analyses	27.6	2.3	1.2	18.3	0.37	0.10	0.07	5.8
Corn, dent, well matured, well eared	28.5	2.3	1.3	19.8	0.40	0.09	0.07	...
Corn, dent, well matured, fair in cars	26.3	2.1	1.1	17.2	0.35	0.09	0.06	...
Corn, dent, immature, before dough stage	20.3	1.8	0.9	12.9	0.26	0.11	0 07	...

Corn stover, mature ears removed	23.7	1.6	0.6	14.0	0.28	0.08	0.10	...
Corn and soybeans, well matured, 30% or more soybeans	28.3	3.2	2.0	19.7	0.40	0.20	0.08	...
Grass silage, considerable legumes	25.6	3.6	2.0	15.5	0.31	...	...	17.1
Grass silage, some legumes	27.6	3.2	1.9	15.6	0.32	...	...	20.7
Grass silage, some legumes, molasses added	25.8	3.2	1.9	15.1	0.31	0.32	0.12	...
Grass silage wilted, molasses added	33.6	4.5	2.6	19.1	0.39	...	...	6.2
Mangels, roots	9.2	1.3	0.9	7.1	0.14	0.02	0.02	...
Oats, molasses added	32.0	2.7	1.4	16.9	0.34	0.10	0.09	17.7
Pea vine	24.5	3.2	1.9	14.0	0.30	0.32	0.06	21.0
Potatoes, tubers	21.2	2.2	1.3	17.4	0.35	0.01	0.05	...
Potato-alfalfa hay	35.9	5.3	3.3	21.1	0.43	...	...	...
Potato-mixed hay	33.7	3.8	2.2	21.6	0.44	...	...	...
Potato-corn meal	31.7	2.0	1.0	27.0	0.55	...	...	...
Rutabagas, roots	11.1	1.3	1.0	9.5	0.19	0.05	0.03	...
Sorghum, sweet	25.4	1.6	0.8	15.2	0.31	0.08	0.05	2.7
Soybean, not wilted	21.8	4.2	2.9	14.6	0.29	0.35	0.09	14.6
Sudan grass	25.7	2.2	1.5	14.4	0.29	0.11	0.04	...
Timothy, not wilted, *no preservative*	30.9	3.3	1.8	18.4	0.37	0.18	0.09	14.1
Timothy, not wilted, molasses added	30.0	3.1	1.6	17.1	0.35	0.16	0.08	...
Turnips	9.3	1.3	0.9	7.8	0.16	0.06	0.02	...
			Concentrates					
Barley, excluding Pacific Coast	89.4	12.7	10.0	77.7	1.57	0.06	0.40	...
Barley, Pacific Coast	89.9	8.7	6.9	78.8	1.59	0.06	0.33	...
Beans, field or navy	90.0	22.0	20.2	78.7	1.59	0.15	0.57	...
Beet pulp, dried	90.8	9.1	4.3	68.2	1.38	0.68	0.10	...
Beet pulp, molasses, dried	92.0	9.1	6.0	72.3	1.46	0.56	0.08	...
Beet pulp, wet	11.0	1.5	0.8	8.8	0.18	0.09	0.01	...
Blood meal	90.5	79.9	56.7	58.9	1.19	0.28	0.22	...

Table 1 (Continued)

AVERAGE COMPOSITION AND DIGESTIBLE NUTRIENT CONTENT OF COMMON FEEDSTUFFS*

Feedstuff	Total Dry Matter (%)	Protein (%)	Digestible Protein (%)	TDN† (%)	DE‡ (therms/lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg./lb.)
Concentrates (Continued)								
Blood flour	90.8	82.2	78.9	81.2	1.64	0.45	0.37	...
Bone meal, raw	93.2	26.2	16.1	18.1	0.37	22.14	10.35	...
Bone meal, steamed	95.2	12.1	...	...	...	28.98	13.59	...
Brewers dried grains	92.4	25.9	20.7	66.0	1.33	0.27	0.50	...
Buttermilk, dried	92.5	32.0	28.8	83.0	1.68	1.34	0.94	...
Citrus pulp, dried	90.1	6.0	5.2	78.2	1.58	1.96	0.12	...
Coconut oil meal, expeller	92.8	20.4	17.3	76.3	1.54	0.21	0.61	...
Coconut oil meal, solvent	91.7	21.3	18.1	68.3	1.38	0.17	0.61	...
Corn and cob meal	86.1	7.4	5.4	73.2	1.48	0.04	0.22	...
Corn, yellow dent, #2	85.0	8.7	6.7	80.1	1.62	0.02	0.27	1.3
Corn, flint	88.5	9.8	7.5	83.4	1.68	...	0.33	...
Corn distillers dried grains	92.3	27.1	19.8	82.7	1.67	0.09	0.37	1.4
Corn distillers dried grains, with solubles	91.9	27.2	19.0	81.0	1.64	0.17	0.68	1.7
Corn distillers dried solubles	93.1	26.9	21.3	80.2	1.62	0.35	1.37	0.3
Corn gluten feed	90.4	25.3	21.8	75.4	1.52	0.46	0.77	3.8
Corn gluten meal	90.7	42.9	36.5	79.9	1.61	0.16	0.40	7.4
Cottonseed, whole, pressed	92.4	28.0	20.2	58.6	1.18	0.17	0.64	...
Cottonseed feed	90.8	39.2	30.6	65.4	1.32	0.15	0.64	...
Cottonseed oil meal, expeller	92.7	41.4	34.4	73.4	1.48	0.18	1.15	...
Cottonseed oil meal, solvent	91.4	41.6	34.5	66.1	1.34	0.15	1.10	...
Fish meal, menhaden	92.2	61.3	49.7	67.0	1.35	5.40	2.81	...
Flaxseed screenings	91.4	15.8	8.8	58.5	1.18	0.37	0.43	...

Flaxseed screenings oil feed	91.3	24.1	13.5	54.6	1.10	0.44	0.63	...
Hominy feed, white	89.8	11.1	7.9	82.9	1.67	0.02	0.58	...
Hominy feed, yellow	90.7	11.1	7.9	83.7	1.69	0.05	0.52	3.1
Linseed feed	90.5	33.8	28.4	74.2	1.50	0.43	0.65	...
Linseed oil meal, expeller	90.9	35.3	30.7	76.3	1.54	0.44	0.89	...
Linseed oil meal, solvent	90.9	35.1	20.5	71.0	1.43	0.40	0.83	...
Meat scrap	93.5	53.4	43.8	65.4	1.32	7.90	4.03	...
Meat scrap, 50% protein	94.0	50.6	41.5	62.2	1.26	10.57	5.07	...
Milk, cow's	12.8	3.5	3.3	16.3	0.33	0.12	0.10	...
Milk, ewe's	19.2	6.5	6.2	26.2	0.53	0.21	0.12	...
Molasses, beet	76.0	6.7	3.5	59.6	1.20	0.16	0.03	...
Molasses, cane	74.5	3.2	7.0	54.9	1.11	0.89	0.08	...
Molasses, cane, dried	96.1	10.3	...	62.6	1.26	...	...	...
Oats, excluding Pacific Coast	90.2	12.0	9.4	70.1	1.42	0.09	0.33	...
Oats, Pacific Coast	91.2	9.0	7.0	72.2	1.46	...	...	...
Oats, rolled (oatmeal)	90.8	16.1	14.5	91.4	1.85	0.07	0.46	...
Oats, groats (hulled)	90.4	16.2	14.6	91.9	1.86	0.08	0.46	...
Orange pulp, dried	89.3	7.0	5.5	78.8	1.59	0.63	0.10	...
Oyster shell, ground	99.6	1.0	..	..	...	38.05	0.07	...
Peanut oil meal, expeller	92.0	45.8	41.7	80.2	1.62	0.17	0.57	...
Peanut oil meal, solvent	91.5	47.4	43.1	74.3	1.50	0.20	0.65	...
Potato meal, dried	90.3	5.0	2.1	65.1	1.32	...	...	...
Rape seed	90.5	20.4	17.3	117.1	2.37	...	...	...
Rice bran	90.0	13.5	9.2	71.0	1.43	0.06	1.82	...
Rice polishings	89.9	11.8	9.0	83.0	1.68	0.01	1.42	...
Rye grain	89.5	12.6	10.0	76.5	1.55	0.10	0.33	...
Rye distillers dried grains	93.0	22.4	13.4	60.2	1.22	0.13	0.41	...
Rye middlings	89.8	17.1	13.0	71.4	1.44	0.06	0.63	...
Safflower oil meal, expeller	90.6	10.7	15.8	48.4	0.98	0.23	0.71	...
Safflower oil meal, with hulls	93.2	23.7	19.0	51.5	1.04	...	...	...
Safflower oil meal, without hulls	91.1	38.4	33.8	64.4	1.30	0.31	0.58	...
Safflower seed	93.1	16.3	13.0	82.4	1.66	...	...	...

Table 1 (Continued)

AVERAGE COMPOSITION AND DIGESTIBLE NUTRIENT CONTENT OF COMMON FEEDSTUFFS*

Feedstuff	Total Dry Matter (%)	Protein (%)	Digestible Protein (%)	TDN† (%)	DE‡ (therms/lb.)	Calcium (%)	Phosphorus (%)	Carotene (mg./lb.)
Concentrates (Continued)								
Skim milk, dried	93.9	33.5	30.2	80.3	1.62	1.26	1.03	...
Sorghum, Kafir	89.8	11.0	8.9	81.6	1.65	0.03	0.31	...
Sorghum, milo	89.0	10.9	8.5	79.4	1.60	0.03	0.28	...
Sorghum, milo, head chops	89.6	9.2	7.0	74.3	1.50	0.14	0.26	...
Soybeans	90.0	37.9	33.7	87.6	1.77	0.25	0.59	...
Soybean oil meal, expeller	89.7	43.8	36.8	77.0	1.56	0.27	0.63	...
Soybean oil meal, solvent	89.3	45.8	42.1	77.2	1.56	0.32	0.67	...
Sweet potato meal	90.2	4.9	0.7	72.7	1.47	0.15	0.14	32.2
Tankage, digester	92.1	59.8	50.8	66.1	1.34	5.94	3.17	...
Tankage, digester, with bone	94.1	49.6	42.2	64.7	1.31	10.97	5.14	...
Wheat, hard, winter	89.4	13.5	11.3	79.6	1.61	0.05	0.42	...
Wheat, hard, spring	90.1	15.8	13.3	80.7	1.63	0.04	0.40	...
Wheat, soft, winter	89.2	10.2	8.6	80.1	1.62	...	0.29	...
Wheat, soft, Pacific Coast	89.1	9.9	8.3	79.9	1.61	...	...	...
Wheat bran	89.1	16.0	13.0	65.9	1.53	0.14	1.17	1.2
Wheat flour middlings	89.8	18.4	16.2	78.2	1.58	0.11	0.76	...
Wheat germ oil meal	89.7	27.3	22.9	84.1	1.70	0.07	1.06	3.0
Wheat screenings, good grade	90.4	13.9	10.0	68.7	1.39	0.44	0.39	...
Wheat standard middlings	89.7	17.2	14.3	76.9	1.55	0.15	0.91	1.4
Whey, dried	93.5	13.1	11.8	78.4	1.58	0.87	0.79	...
Yeast, brewers, dried	93.4	44.6	38.4	72.4	1.46	0.13	1.43	...
Yeast, torula, dried	93.3	48.3	41.5	69.9	1.41	0.57	1.68	...

Table 2

COMPOSITION OF CALCIUM AND PHOSPHORUS SUPPLEMENTS*

Mineral Supplement	Calcium		Phosphorus		Fluorine
	%	gm./lb.	%	gm./lb.	%
Bone meal, raw, feeding	22.7	103	10.1	46	0 030
Bone meal, special steamed	28.7	130	13.9	63	
Bone meal, steamed	30.0	136	13 9	63	0 037
Defluorinated phosphate rock *a*†	21.0	95	9.0	41	0 150 or less
Defluorinated phosphate rock *b*†	29.0	132	13.0	59	0 150
Defluorinated superphosphate	28.3	128	12.3	56	0.150
Dicalcium phosphate	26 5	120	20.5	93	0 050
Disodium phosphate			8.6	39	
Limestone (high calcium)	38.3	174			
Monocalcium phosphate	16.0	72	24 0	109	0 050
Monosodium phosphate			22.4	102	
Oyster shell flour	36.9	167			
Spent bone black	22.0	100	13.1	59	

* *Nutrient Requirements of Beef Cattle*, revised 1958, National Research Council

† Because of the limited number of products on the market, figures are given for two types of defluorinated rock which are being produced for livestock feeding

Table 3

ESTIMATED CAROTENE CONTENT OF FEEDS IN RELATION TO APPEARANCE AND METHODS OF CONSERVATION*

Feedstuff	Carotene
	(mg./lb.)
Fresh green legumes and grasses, immature	15 to 40
Dehydrated alfalfa meal, fresh, dehydrated without field curing, very bright green color†	110 to 135
Dehydrated alfalfa meal after considerable time in storage, bright green color	50 to 70
Alfalfa leaf meal, bright green color	60 to 80
Legume hays, including alfalfa, very quickly cured with minimum sun exposure, bright green color, leafy	35 to 40
Legume hays, including alfalfa, good green color, leafy	18 to 27
Legume hays, including alfalfa, partly bleached, moderate amount of green color	9 to 14
Legume hays including alfalfa, badly bleached or discolored, traces of green color	4 to 8
Non-legume hays, including timothy, cereal, and prairie hays, well cured, good green color	9 to 14
Non-legume hays, average quality, bleached, some green color	4 to 8
Legume silage	20 to 30
Green silage	5 to 20
Corn and sorghum silages, medium to good green color	2 to 10
Grains, mill feeds, protein concentrates, and byproduct concentrates, except yellow corn and its byproducts	0.01 to 0.2

* *Nutrient Requirements of Beef Cattle*, revised 1958, National Research Council (table prepared by the late H. R. Guilbert, Davis, California).

† Green color is not uniformly indicative of high carotene content.

Table 4

Breed Associations

American Angus Breeders' Association; 3201 Frederick Boulevard; St. Joseph, Missouri; Frank Richards, secretary.
American Belted Galloway Cattle Breeders' Association; South Fork, Missouri; Charles C. Wells, secretary.
American Brahman Breeders Association; 4815 Gulf Freeway, Houston 23, Texas; Mrs. Margaret Sunday Watkins, recording secretary
American Charbray Breeders Association; 475 Texas National Bank Building; Houston, Texas; Mrs. Quinta Arrigo, secretary.
American Devon Cattle Club; 704 Suffield Street, Agawam, Massachusetts; Kenneth Hinshaw, secretary.
American Galloway Breeders' Association; South Fork, Missouri; Charles C Wells, secretary.
American Hereford Association; Hereford Drive, Kansas City 5, Missouri; Paul Swaffar, secretary.
American International Charolais Association; 437 Texas National Bank Building, Houston, Texas; Mrs. Edna McIntyre, recording secretary.
American Milking Shorthorn Society; 313 South Glenstone, Springfield, Missouri; W. E. Dixon, secretary.
American Polled Hereford Association; Mason Building, 1110 Grand Avenue, Kansas City 6, Missouri; Don W. Chittenden, secretary.
American Red Danish Cattle Association; Marlette, Michigan; Mrs. Harry Prowse, secretary.
International Brangus Breeders Association; 646 Livestock Exchange Building, Kansas City 2, Missouri; Jesse L. Dowdy, executive secretary.
American Shorthorn Breeders' Association; 909 Livestock Exchange Building, Omaha 7, Nebraska, Kenneth R. Fulk, secretary.
National Polled Cattle Club; Nicollet, Minnesota; Walter Schultz.
Polled Shorthorn Society; Livestock Exchange Building, Omaha 7, Nebraska, Kenneth R. Fulk, secretary.
Red Poll Cattle Club of America; 3275 Holdrege Street; Lincoln 3, Nebraska, Wendell H. Severin, secretary.

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